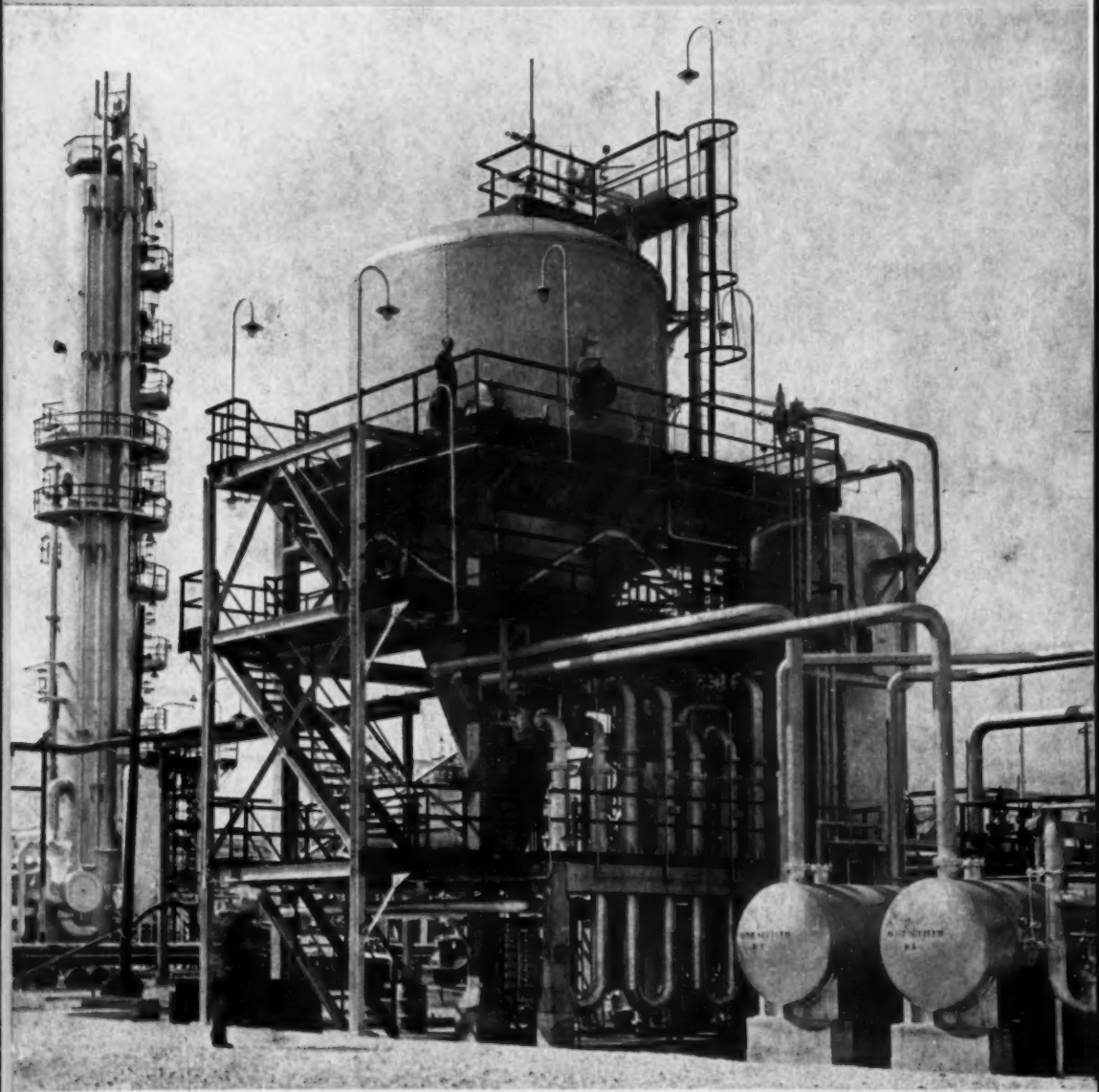
DECEMBER 1951

INDUSTRY AND POWER

For Executives and Engineers Responsible For Engineered Plant Services



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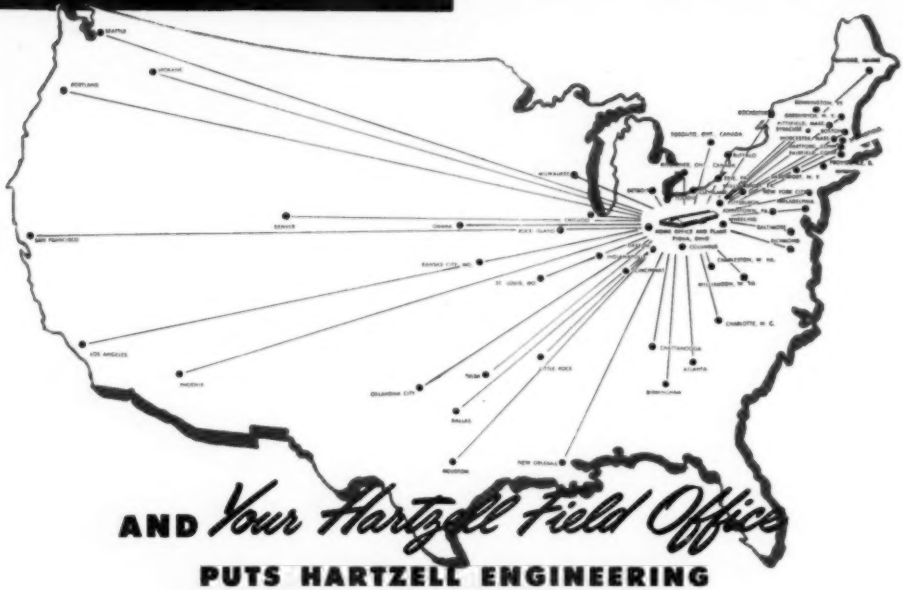
POWERFUL Fans and Blowers...



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If you've got an "incurable" air-moving problem, dump it in our lap. It's for just such service that we have built our engineering-distribution system. Each of our field offices—and there's one near *you*—is there to *help you get results*, not merely to calculate the dollars and cents of a sale.

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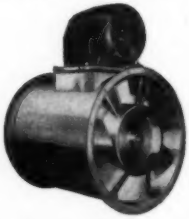
You can bank on what he tells you. That's why he's with Hartzell. And that's why Hartzell customers move air effectively at minimum cost.

If you foresee an air-moving problem for the future, we urge you to call your Hartzell man in now. Give us all the time you can. Within the past few months we have practically doubled plant capacity, and each month we are setting new production records, but we still haven't caught up with the demand for Hartzell products.



Why the demand? It's simple. Hartzell fans and blowers move air efficiently.

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HARTZELL PROPELLER FAN CO. (Div. of Quick-Hilts Corp.) PIQUA, OHIO

PROPELLER-TYPE FANS AND BLOWERS—ROOF VENTILATORS—UNIT HEATERS • ENGINEERING OFFICES IN PRINCIPAL CITIES

You can belt down handling costs

NO MATTER what the material you have to move—inside or outside your plant—it'll pay you to investigate conveyor belts. The G.T.M.—Goodyear Technical Man—can analyze your problems drawing on experience gained from successful installations throughout industry—match *your* problems with others to prove that conveyors can be the most economical cargo-handlers. And he can choose from a wide selection of belt constructions to specify the one that will give you the longest, most trouble-free service on your particular job. Get in touch with the G.T.M. today by calling your nearest Goodyear distributor, or writing Goodyear, Akron 16, Ohio.

THREE TYPICAL G.T.M.-SPECIFIED CONVEYORS THAT ARE CUTTING COSTS

◄ Old-style chain conveyors outperformed by a Goodyear conveyor 3 to 11 Over 1,000 tons of fish per hour are carried into the processing plant of this fertilizer maker, at lower cost per ton than ever before.

Paper mills everywhere are turning to conveyors to handle logs, chips and other raw materials. Here, too, the G.T.M. has made appreciable savings by designing systems to replace former materials-handling systems, ▼ operate at lower cost.

GOODYEAR INDUSTRIAL RUBBER PRODUCTS

GTM-Specified CONVEYOR BELTS

A few of the materials and service conditions that can be handled

- Single flights up to 5 miles; lifts to 1500'
- Extremely abrasive materials
- Hot materials
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- Underground service in coal mines
- Sanitary handling of foods in canneries
- Extreme oil conditions
- Soupy materials, like cement
- Boxes and packages in plants and stores
- Packaged or bagged materials on inclines
- All types of grain handling

▲ Assembly-line operations can be conveyorized, too—with Goodyear's CHEMIGUM belts that withstand the attack of oil 50 times as well as natural rubber. That means longer life—lower cost—fewer interruptions of output.

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FOR HOSE, FLAT BELTS, V-BELTS, MOLDED GOODS, PACKING, TANK LINING, RUBBER-COVERED ROLLS *built to the world's highest standard of quality, phone your nearest Goodyear Industrial Rubber Products Distributor.*

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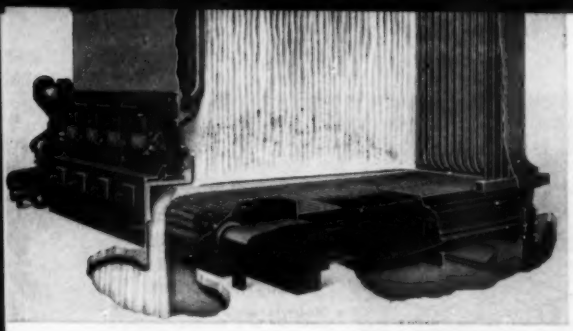

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Insure yourself

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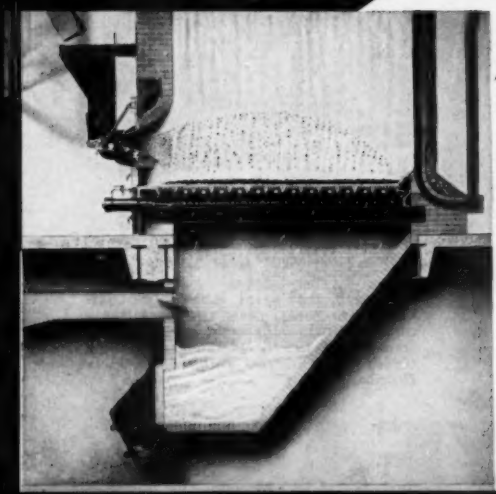

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District Offices in Principal Cities . . . Works at Monroe, Michigan

Edited specifically for executives and engineers responsible for the selection, installation, operation & maintenance of equipment required for Engineered Plant Services*

INDUSTRY AND POWER

The Magazine for Engineered Plant Services

VOLUME 61 **DECEMBER, 1951** NUMBER 6

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Survey of current practices in operation of steam generators designed specifically for firing lignite coals found in the north central and south central areas of the United States: Subjects covered include:

Comparative analyses of anthracite, bituminous and lignite coals.
Listing of major power stations in the United States firing lignite.
Design and construction of furnaces and boilers.
Comparison of firing methods: Traveling grate and spreader stokers; pulverizers.
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Engineered Plant Services

By ***Engineered Plant Services*** we mean the ***providing*** or ***generating, transmitting, controlling, applying,*** and ***maintaining*** of POWER, STEAM, MECHANICAL DRIVES, HEAT, ELECTRICITY, AIR, WATER, and other engineered services in and for all areas of the industrial establishment as required for production and operation. This includes Lubrication, Piping Systems, Industrial Waste Disposal, Corrosion Control, Electrical Systems, Industrial Heat, Coal and Bulk Handling, Dust and Fume Control, and other related services of an engineering nature.

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TO A MINIMUM

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FOR pH AND PHOSPHATE

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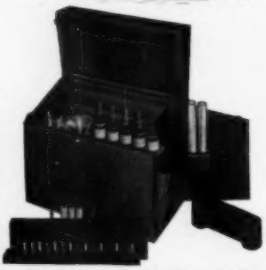
WITH A TAYLOR
BOILER WATER
COMPARATOR!



It takes only a minute or two to determine pH or Phosphate, since all color standards necessary for a determination are enclosed in one plastic slide . . . no breakable single standards to handle. Maximum accuracy is assured . . . *for all Taylor Liquid Color Standards carry an UNLIMITED guarantee against fading.* Their low cost, extreme accuracy and simplicity of operation have made Taylor Boiler Water Comparators the accepted tool throughout industry.

Model P contains either High or Low Phosphate Comparator. Model W (shown above) contains same, plus 3 pH slides (pH 7.2 to 8.8); (pH 8.6 to 10.2); (pH 10 to 11.6) plus accessories and instructions for use.

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VALUABLE REFERENCE BOOK
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Acorns of science

Developments not yet available, but of interest to those responsible for Engineered Plant Services

New Magnesium Alloys

• The new process is a metallic powder compression method in which the magnesium and alloying powders are mixed and extruded in a variation of older methods. From an Air Force research report, the alloys are stronger than those having the same composition but formed conventionally by casting and extruding billets. In addition, many new alloys not obtainable by casting are possible, and the new compositions have greater strength, improved corrosion resistance and better fabrication characteristics. The method further offers possibilities of designing alloys with specific properties.

D-C Isolation Metering

• Magnetic amplifiers, the modernized, saturable reactors, continue to find novel applications. This one is of interest because it functions as a isolation transformer, as well as an amplifier, for metering on high voltage d-c buses. In the application reported by Westinghouse Electric Corporation, the voltage drop across a shunt in the d-c circuit is applied to the control winding of the reactor. The rectified current output of the a-c windings is proportional to the shunt voltage and, completely insulated from the high voltage bus, is applied to the controlling equipment which regulates bus current.

New Names in Electronics

• "Transistor", a tiny amplifier 1/400 the size of a vacuum tube but doing the same job by control of barrier layer conduction, has recently been announced by Bell Telephone Laboratories. The new type, which has uniform performance, will get trial use next year.

"Thermistors", metal-ceramics with inverse temperature-resistance characteristics have been announced as being in the engineering appraisal stage by Carboloy Department of the General Electric Company. Increase of resistance with decrease of temperature is extremely sharp. For one grade, it rises from 1/100 ohm-in. at 600 F to 2000 ohm-in. at 50 F. Another grade varies between 1/10 and 20,000 ohm-in. over the same range. They are pure electronic conductors, may be used with either a-c or d-c and may replace highly intricate apparatus.

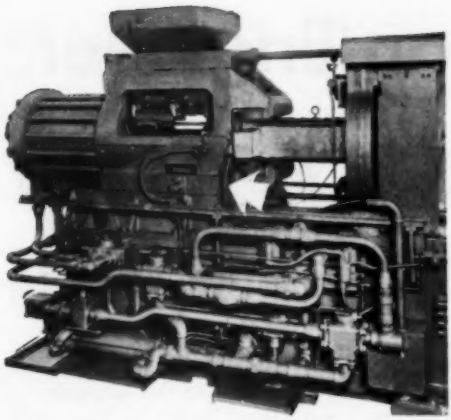
Vacuum Distillation

• Patent No. 2,562,153 describes a new method and apparatus for high vacuum or molecular distillation wherein the fluid flows filmwise down a substantially vertical evaporating surface, and the condensate collected on a rotating condenser is thrown upwardly and back upon the evaporating surface by centrifugal means.

Paper From the Farm

• Interest in sources of paper fibers is reflected in recent reports. One from Forest Products Laboratory offers promise of raw material for newsprint from sugar cane bagasse. Basis of the process is extraction of residual sugar from bagasse pith cells.

A bulletin from the Northern Regional Laboratory of the Department of Agriculture reviews two processes which produce high yields of strong, easy bleaching papermaking pulps from straw. They are the neutral-sulphite and the mechano-chemical processes developed by that laboratory. Because costs of collecting and baling straw have been lowered, and a simple method of preserving it has been worked out, it is believed that increasing requirements for paper and board products can be met without excessive drain on present pulp wood resources.



In this Model 10 H-32 oz. Reed-Prentice plastic injection molding machine, Sealtite protects the heating chamber control wiring.

THE Reed-Prentice Corp., world's largest makers of plastic injection molding machines, solves numerous wiring-protection problems on its equipment with flexible Sealtite* Electrical Conduit.

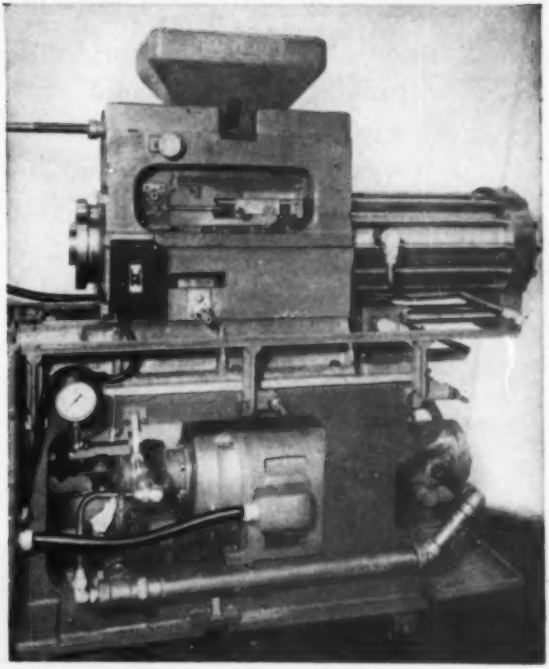
Where connections are cramped or bends are short, Sealtite is far easier to install. Where movement is called for, Sealtite permits it; where vibration exists, Sealtite absorbs it. Sealtite's liquid-tight, synthetic jacket resists oils, most chemicals, and gases. Its tough steel core stands up under impact.

Sealtite's adaptability on machines like these is only one example of its usefulness. It's equally versatile in chemical plants, food processing industries, for making cramped conduit installations anywhere . . . for permanent or temporary wiring installations. Your electrical supply house carries Sealtite—and will be glad to tell you more about it. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

*Trademark

Let SEALTITE flexible and liquid-tight conduit simplify your wiring

Reed-Prentice Model 10 E-16 oz. plastic injection molding machine showing plunger end. The horizontal Sealtite Conduit carries wiring to 30-hp motor. The vertical Sealtite Conduit carries control leads to synchronous timer.



for **flexible, liquid-tight** electrical conduit . . .

specify SEALTITE

AN ANACONDA® PRODUCT

How an Engineer

46%

Fred Koenig's notes which were incorporated in his report to the Wagner Brewing Co., Columbus, Ohio, in Oct. 1951.

Cost of new power plant	$128,000
Coal tonnage (old plant)	8,420
Coal tonnage (new plant)	4,700
Fuel costs (old plant)	$ 54,730
Fuel costs (new plant)	$ 32,000
Yearly savings on fuel	$ 22,730
Labor costs (old plant)	$ 41,496
Labor costs (new plant)	$ 19,496
Reduction in present labor costs	$ 22,000
Yearly savings	$ 44,730

Amortization time, new power plant— 2 years, 11 months.

Fred W. Koenig

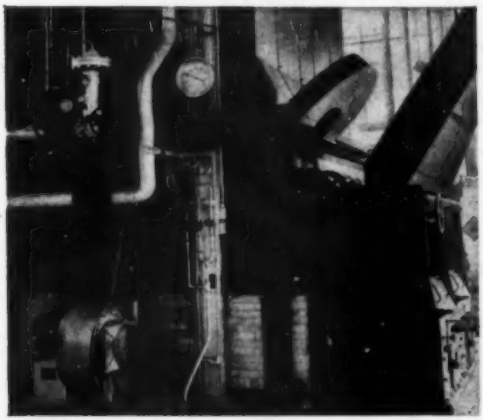
CHIEF ENGINEER
OHIO LICENSE

FOR HIGH EFFICIENCY
FOR LOW COST

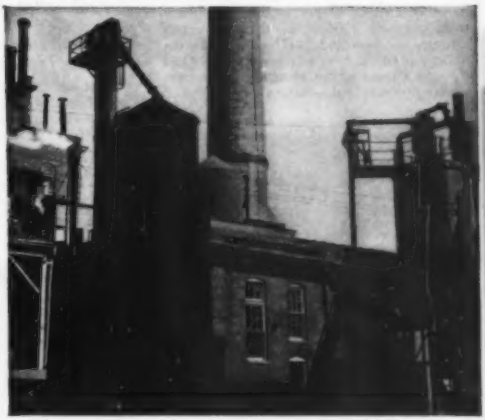
Slashed Operating Costs *with coal!*

IN FIRST YEAR OF OPERATION, NEW POWER PLANT EVEN BETTERS FRED'S ESTIMATE!

Fred Koenig calculated a saving of $40,000. When the figures were in—after the first full year of operation—the saving actually amounted to $44,730!



Here's the coal-fired installation that engineer Koenig recommended, after carefully considering gas and oil as fuels. Specifically designed to get the most energy from today's coals, it saved the Wagner Co. $22,730 on fuel alone in the first year!



This large-capacity silo feeds coal automatically to the Wagner Company's power plant. It cuts handling costs—permits bulk buying of coal at lower rates—assures the Wagner Company of a steady, dependable source of power!

Today, bituminous coal, when used with modern equipment, is the most economical fuel for industrial use. Coal is now more efficient because it's *prepared* . . . washed and cleaned of all impurities. Modern, coal-fired equipment adds from 10% to 40% to the power obtained from the same amount of coal in years gone by.

And automatic controls, together with modern coal- and ash- handling apparatus, have dramatically reduced labor costs, done away with inconveniences—*making bituminous coal the best industrial fuel by far!*

America's coal mines are so productive that there will be no shortages to plague the companies that use coal as the source of their power . . . America's ample supply of coal is the best possible assurance that the price of coal will remain more stable than those of other fuels. Coal is always the safest fuel when it comes to both storage and use, factors of more than usual importance in these unsettled times.

BITUMINOUS COAL INSTITUTE

A Department of National Coal Association, Washington, D. C.

YOU CAN COUNT ON COAL!

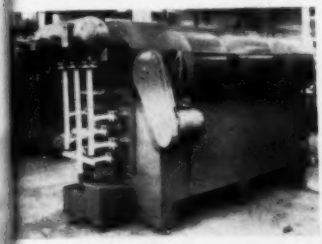
New equipment and developments

Highlights of new products by leading manufacturers

Each new product item has a key number for your convenience in asking for additional, detailed information. Insert key number on return post card on page 133

1—Spray cooler need not be defrosted

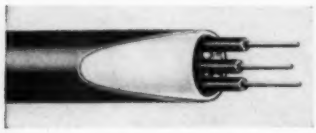
Niagara Blower Co. announces an improved model No Frost spray cooler applying to the refrigeration and refrigerated storage of products that are sensitive to moisture content of air. Equipment differs from previous models in that air enters through the fans and is blown through the units. Air passes over refrigeration coils and through a spray of No Frost liquid solution, which prevents condensation of water and



formation of ice or frost on the coils. Chilled air, which may be as low as minus 20 deg F, passes direct from the spray chamber into the room. Thus, the air contains no reheat from fan energy and, therefore, higher humidity air is made available. There is no cooling capacity loss from accumulation of frost on refrigerating coils, no interruption for defrosting and no reheat added to the air. This affords closer control of conditions with resulting improvement in the quality of products held in refrigerated storage.

2—Electrical conduit resists corrosion

Samuel Moore & Co. announces a plastic armored electrical metallic tubing for use where corrosive atmospheres necessitate frequent replacement of electrical conduit. The Dekoron conduit is made by a patented extrusion process. A 0.020 in. coating of tough, corrosion-resistant vinyl or polyethylene plastic is extruded over standard galvanized electrical metallic tubing. By varying the thickness and composition of the plastic armor, the conduit can be given any desired dielectric properties. It is impervious to corrosive effects of moisture, salt air, acids, alkalies, oils and greases and is immune to normal temperature changes. Fabrication and installation are easy and require no special tools. Standard compression type couplings and connectors wrapped with insulating tape are used at joints. Black is standard but special colors can be supplied. If desired, the plastic coating can be applied over standard rigid conduit instead of galvanized electrical tubing.



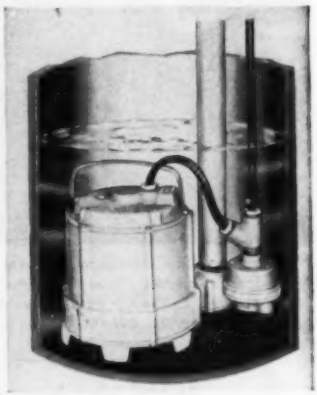
3—Faults or crosses located exactly

Testing and fault locating instruments now being offered by R. F. Miller & Sons enable electrical maintenance men to determine the exact location of faults or crosses by a direct meter reading. It is a portable device, which utilizes a principle little affected by high resistance crosses or faults. It will detect the exact location of line-to-line or line-to-ground crosses and is not affected

by stray or parasitic currents invading ground connections. A built-in ohmmeter measures resistance from 0 to 2 megohms. Current for ohmmeter and neutralizer is supplied by a self-contained battery. The instrument accurately detects the location of a fault or cross on any conductor, which has a resistance of at least 0.1 ohm for each 50,000 ohms of resistance of the fault or cross.

4—Utility pump is submersible

Completely submersible utility pumps for permanent or portable applications are announced by Kenco, Inc. In addition to usual industrial sump applications, the compact unit, weighing only 50 lb, can be used for draining flooded areas, pumping out ex-



cavations and ditches, and draining tanks and vats. Of all bronze construction and driven by a 1/3 hp motor hermetically sealed in oil, the pump has a capacity of 3300 gph. The submersible feature is made possible by the Kenco automatic liquid level control switch, which eliminates need for a float, and which has no moving parts exposed to water. Air pressure created by water rising in the switch skirt moves a diaphragm, which in turn trips the switch. Pumping action sustains switch operation, resulting in sumps being pumped dry within 5/8 in. of bottom. Model P-109MA provides both manual and automatic pump operation.

5—Rotary pump has sliding vanes

Heavy duty vane type rotary pumps have been added to the existing line of rotary pumps manufactured by Worthington Pump and Machinery Corp. All models are positive displacement, sliding vane type in which the pressure of the liquid being pumped maintains contact of the vanes against the

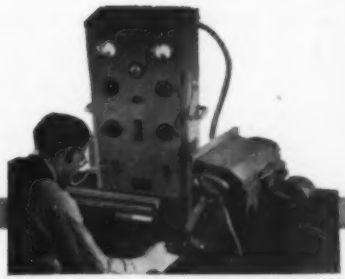
(Continued on page 14)

TO REQUEST ADDITIONAL FREE DATA

Each paragraph in this section is numbered —beginning with number 1. This is the "key" number which should be inserted on the return post card on page 133. Just fill in, tear out and mail this card. Our Reader Service Department will handle your request promptly

SMALL PLANTS, TOO!

CAN PROFITABLY USE THE *Nalco* SYSTEM



X-Ray equipment, used in the Nalco Laboratories as an aid toward providing positive water treatment results.

● *Water treatment service for small plants is an important part of Nalco's business.*

This indicates two things:

Small plants find Nalco Service Agreements a profitable investment . . . And

Nalco facilities and services are geared to handle — efficiently and economically — the needs of *any* plant, regardless of its size or the volume of water treatment chemicals used.

If your plant is a small one, you can get the same security from water treatment difficulties as many of the world's largest steam generating stations have with Nalco Service Agreements — and at a cost entirely in line with the size of *your* plant and your problems. Write today for complete details, or call your Nalco Representative.

NATIONAL ALUMINATE CORPORATION
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Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

WITH NEW ILLUMINATOR ON YARWAY FLAT GLASS GAGE . . .

BOILER WATER LEVEL *Shines*

It's light! It's bright! It's right! You see instantly the accurate boiler water level in your Yarway Flat Glass Gage because *the meniscus at water level stands out like a brilliant star* . . . thanks to the new Yarway Type "M" Illuminator.

The Type "M" Illuminator is specially-designed to give maximum brilliance to Yarway flat glass inserts, and to spot the water level over its entire traverse. The superior penetration of its blue-white light cuts through extraneous light, dust particles in the air, and deposits on the gage glasses. Effective over longer distances.

New or already-installed Yarway Flat Glass Gages may be equipped with the Illuminator. Yarway Illuminators may be installed in pairs on four-glass gages.

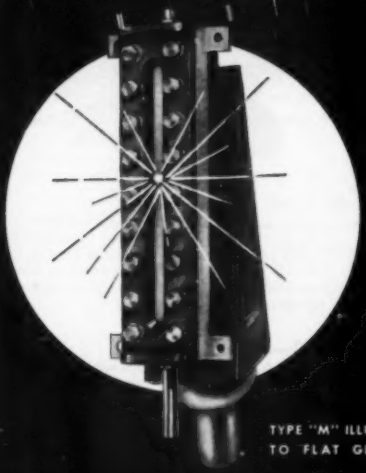
Get in touch with your nearest Yarway office for further details on this latest Flat Glass Gage development, or write direct to . . .

YARNALL-WARING COMPANY
109 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

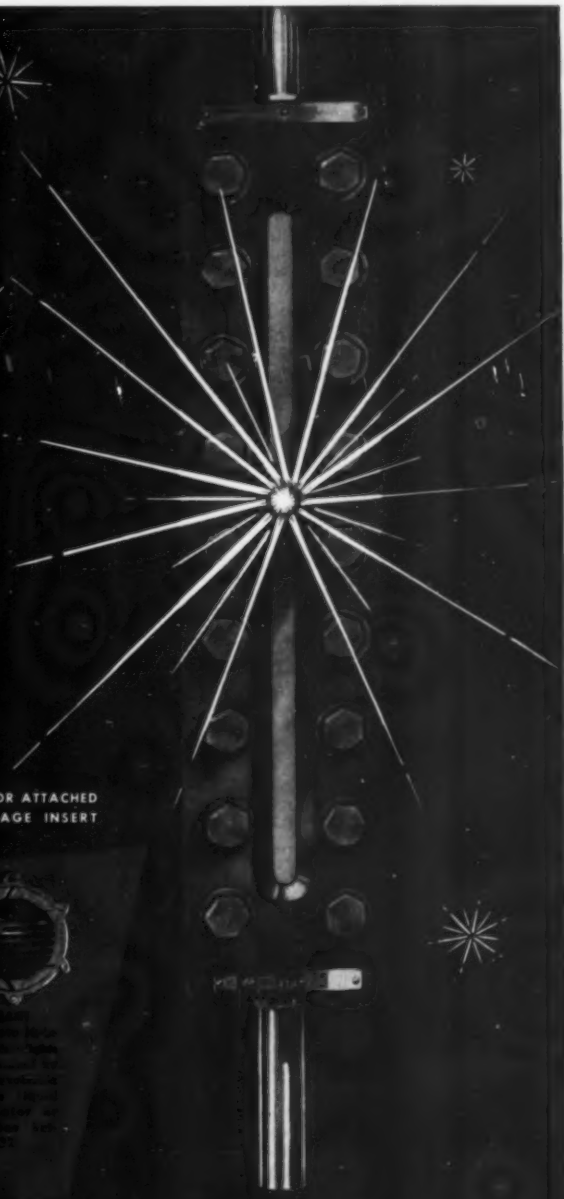
A COMPLETE YARWAY WATER LEVEL SYSTEM

YARWAY STEAM

like a Star



TYPE "M" ILLUMINATOR ATTACHED
TO FLAT GLASS GAGE INSERT



PLANT EQUIPMENT

New equipment and developments

(Continued from page 10)

liner. The pumps are to be made in both internal and external bearing design, the external bearing models being especially suited for non-lubricating liquids such as gasoline and kerosene. They have built-in relief valve and can be made in either standard fitted, bronze fitted or all bronze construction.

6—Switch operates at low pressures

General Controls Co. is now producing an inexpensive diaphragm switch known as the L-38 low pressure switch. The unit contains a normally open or normally closed switch actuated by gas pressure and applicable to heating plant installations where it is necessary to operate a switch by a variation in gas pressure. Pressure applied against a spring-loaded diaphragm operates to tilt a

mercury tube switch. The diaphragm is made of material impervious to all types of gases, including liquefied petroleum gas. The spring loading mechanism may be easily adjusted by a set screw located at the top cover plate. Also featured is a built-in level in the top cover to aid in installation. The switch is suitable for air or gas applications only, at rated pressures. The operating point is adjustable over a pressure range of 3 to 12 in. of water and operates from pressure differential of 2 to 4 in. of water.

7—Limit switch hermetically sealed

Completely hermetically-sealed limit switch is announced by the Electro-Snap Div. of the Exhibit Supply Co. It has many industrial applications with special value in places where ordinary splash-proof or enclosed switches are not adequate because of humid or corrosive atmosphere, excessive dust and other difficult conditions. Because of the hermetic sealing (with inert atmosphere) this switch is considered proof against freezing, corrosion, explosions, accumulation of dust on contacts, tampering and misadjustments. Performance is said to be equal at sea level or 50,000 ft. An important feature is a tipping diaphragm action to prevent jamming from ice formation.

Hardened steel pivot provides diaphragm support. Other details include d.p.t. switching with nearly simultaneous break, with s.p.d.t. optional. A 4 or 8 pin connector eliminates condensation around terminals. All components are bonded in an integral unit by copper brazing, and the cover is sealed by induction soldering. The switch weighs 0.38 lb with overall dimensions of a 2-9/16 x 1-9/16 x 1-3/16 in. Actuator is capable of more than 100,000 electrical operations or 200,000 mechanical movements. Internal switching mechanism will endure in excess of 10,000,000 mechanical cycles.

TO REQUEST ADDITIONAL FREE DATA

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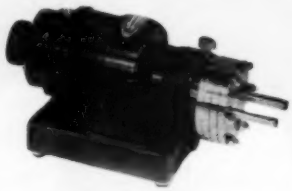
8—Reflectors are quickly detached

Turnlox detachable reflector, which permits removal of reflector and lamp as one unit for easy cleaning, is offered by Benjamin Electric Mfg. Co. This unit permits quick and easy removal of reflector and lamp from the hood containing the wiring terminal base by means of a slight upward pressure on the rim of the reflector and less than a quarter turn to the right. Electrical and mechanical connections are joined simultaneously with the engagement of the three-point bayonet coupling. Automatic polarization is provided. The hoods have easily wired porcelain terminal bases, which fit any medium or mogul base Turnlox reflector assembly. A complete line of heavy-duty, porcelain enameled steel reflectors is available.

9—Small pump meters variety of liquids

Mechanical Products Corp. announces their Maisch line of small metering pumps of fixed and variable capacity for dispensing controlled volumes of hot or cold, viscous or non-viscous liquids with smooth, non-pulsating flow. The units are especially valuable in handling liquids such as soft drinks, coffee, soaps, oils, fats, grease, wax, glue, plasma, vaccine and serum. The precision built pumps have floating stainless steel gears, running within a self-lubricating carbon housing. Pump heads can be quickly removed and sterilized. Governor-controlled



units provide full power at all speeds from 10 to 750 rpm. Variable-speed transmission units are adjustable in capacities from 0 to 50 ml per sec. Liquid is dispensed as soon as motor starts, and a check valve prevents dripping when motor stops.

10—Atomizing nozzle has in-line supplies

Spraying Systems Co. announces their ⅛ JBC pneumatic atomizing nozzle, featuring in-line air and liquid supply pipe connections in the back of the nozzle. This facilitates mounting and also makes possible portable operation. The nozzle can be fur-

nished made of brass or stainless steel and is designed for use with all the manufacturer's standard fluid and air nozzle assemblies to meet a wide range of requirements in spray type, size and volume. Assemblies available include both pressure and siphon setups for producing round, flat and wide-angle round sprays.

(Continued on page 16)

NOW!

EDWARD WELDED BONNET UNIVALVES* for service up to 2500 lb at 1000 F

For high pressure service, especially when temperatures are high and variable too, Edward forged steel Univalves are the logical choice.

Edward Univalves are now regularly built in both 1500 and 2500 lb 1000 F series in all sizes from ½ in. through 2 in.; 1½ in. and 2 in. suitable for A.S.M.E. Code blow-off service.

LOOK AT THESE ADVANTAGES . . .

1 LEAKPROOF WELDED BONNET Patented seal welded body-bonnet joint, designed for disassembly if ever necessary. No bonnet joint to leak.

2 PERFECT ALIGNMENT Integral one-piece bonnet with renewable bronze yoke bushing. Special welding fixtures and single set-up machining result in absolute alignment of all working parts.

3 HARD FACED SEAT AND DISK Continuous ring of Stellite applied directly on valve body forms seat, and disk is alloy steel with a Stellite face.

4 LOW PRESSURE DROP Inclined stem construction makes flow passages so straight you can see through them, yet retains globe valve tightness. Pressure drop reduced 25 to 50 per cent, and wear-producing turbulence is at a minimum.

5 FOOLPROOF BACKSEAT Packing isolated to prevent blow-out when repacking under pressure. Backseat and deep cooling chamber protect packing in service.

6 EASY PACKING ADJUSTMENT Through - bolted, accurately guided gland.

AND THESE PLUS FEATURES, TOO . . .

- ✓ *Maximum piping flexibility*
- ✓ *Excess weight eliminated*
- ✓ *Oversize knobbed handwheels*
- ✓ *Re-enforced EVolpak® molded packing*
- ✓ *Centerless ground stainless steel EValloy® stems*
- ✓ *Abrasion resistant EValized® junk rings*

Edward Intex® valves for 1500 lb 1000 F service available in same size range for services where bolted bonnet globe valves are desired.

Write today for new Edward Catalog 12-G6 describing Univalves and Intex Valves.

***Univalves, EVolpak, EValloy, EValized and Intex are registered trade marks of Edward Valves, Inc.**

Edward Valves, Inc.

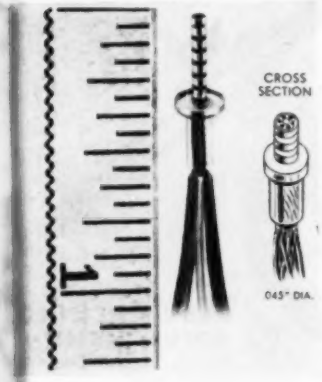
SUBSIDIARY OF ROCKWELL MANUFACTURING CO. 49 W. 144TH ST. EAST CHICAGO, INDIANA

New equipment and developments

(Continued from page 14)

11—Slip ring assembly exceptionally small

Designed for incorporation in miniaturized equipment, a slip ring assembly of very small size and high dimensional accuracy is being manufactured by Electro Tec Corp. Units of from two to six rings are available with a separate lead feeding each ring. Rings are only 0.045 in. in dia. Width of each ring is 0.030 in. and barrier width 0.015 in. Weight of six ring unit is 5.5 grain (1/8 oz). All leads are color coded.



Despite the minute size, accuracy of construction is so precise that the assembly withstands a required 1000 v hi-pot test, ring to ring and between leads. The dimensional accuracies maintained in this unit are the result of a process, which involves electroplating the rings into the grooves of a precision machined, one-piece dielectric core. Subsequent machining and polishing insures absolute concentricity and accuracy.

12—Guns handle bulk or cartridge caulk

Caulking guns designed especially for use with Rub-Bub chromated caulk are announced by Samuel Moore Chemical Co., Inc. Known as Rub-Bub Calkezee caulk guns, the applicators are made of steel with a gray baked-enamel finish. Available in two models, they feature contoured handles, positive ratchet drive, long trigger stroke and instant pressure release. Model 1MX6 was designed for use with metal cartridges in which Rub-Bub chromated caulk is sealed but will also handle any other one-pint fiber or paper spouted cartridge. The shell type gun Model 1MX7 is designed for use with bulk caulk but can also be used with cartridges. A large variety of metal nozzles is available.

13—Noises located electronically

Location of friction noises in bearings, pistons, gears, ratchets, cams, traps, clutches, pipe lines, valves and other mechanisms is possible with a portable electronic instrument made by Anco Instrument Div. Known as the Elec-Detec, this electronic stethoscope employs a metal probe, which serves as a microphone transmitting impulses electrically to headphones. It localizes the source of tell-tale noise, helps diagnose the trouble and determine quickly where to make repairs without tearing down the entire equipment. The electric amplifier and sensitivity control makes possible the detecting of sounds at low speed that otherwise could be heard only at high speed. It is furnished complete with high impedance type headphones, batteries and leather carrying case.

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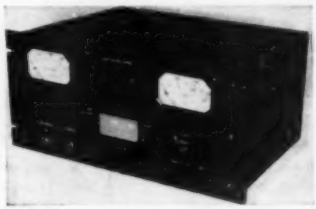
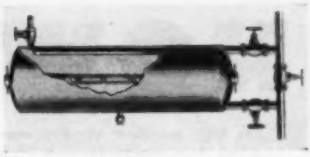
14—Regulated power supply offered

The Electronic Measurements Co. announces production of a regulated power supply, designated Model 208-A. Specifications are as follows: Output (No. 1) 0-600 v d-c at 200 ma (continuously variable); regulation less than 0.5 per cent no load to full load; hum less than 5 mv; output impedance less than 2 ohm at 20 c or more; positive or negative ground; low voltage 6.3 v a-c at 10 amp unregulated; metered output. (No. 2) 0-150 v d-c at 5 ma (continuously variable); regulation within one per cent at 150 v; line input 105-125 v; voltages available from front and rear; size overall 8-3/4 x 19 x 12 in.; weight approximately 47 lb net.



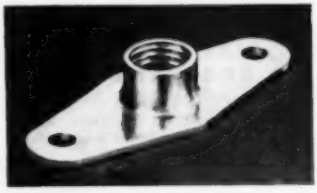
15—Catalytic process eliminates scale

The Sola catalytic process for the treatment of industrial and potable water to eliminate scale, and reduce rust and corrosion in boilers, tanks and all types of water systems, has been announced by the Sola Catalytic Co. The catalytic action of the treatment does not change the chemical structure of the water in any way, but stops the formation of new scales and gradually removes all old existing scale. It also reduces corrosion to a great degree. Other benefits include elimination of chlorination, and of the need for dosing and periodic analysis and control required when chemical softeners are used. The catalytic process creates a dispersion of the elements in the water that have an affinity for forming scale and corrosion.



16—Anchor nut made of spring steel

Self-locking anchor nut, simple in design and made on high production stamping equipment, was announced recently by the Kaynar Mfg. Co., Inc. The nut consists of a flanged anchoring portion integral with a thin-walled drawn shell, which is fully tapped throughout its length. Made of high carbon annealed spring steel, the nut is crimped and then heat treated to provide an extremely strong flexible threaded portion that grips the bolt within the span of the normally required number of threads without necessitating an auxiliary locking device. It is lower in height and, because of its high strength, is comparatively light in weight. It is claimed to provide exceptional locking torque uniformity even with large variations in bolt dia. It may be reused many times without loss of locking torque, and cross-threading is practically impossible due to the hardness of threads. It may be used in high temperature applications up to 700 deg F, and it is not adversely affected by lubricants or solvents. The nut is made in the solid anchor, floating anchor and gang channel types.



17—Glass cloth coated with silicone rubber

Silicone rubber treated glass cloth for motor and cable insulation is now in production by General Electric Co. In the dipping process that is used, glass cloth is passed through a liquid solution of silicone rubber. After the application of heat to cure the rubber, the treated fabric is ready for use. The process is continuous. High heat re-

(Continued on page 20)

FOR PERFORMANCE YOU CAN **BANK** ON

Operating economy *is* an important factor in the selection of steam generating equipment; but equally important is dependability. These two basic considerations are such well-known attributes of Superior Steam Generators that Superior units are repeatedly specified for public utilities, hospitals, industrial plants, and similar critical installations.

Superior Steam Generators are built to develop their maximum rated capacities at thermal efficiencies guaranteed to exceed 80% . . . not for a day, or a month, but for years to come.

You can ***bank*** on their savings due to operating economy . . . but, more important, you can ***bank*** on the dependability of Superior Steam Generators for years of trouble-free service.

FOR COMPLETE DETAILS, WRITE TODAY FOR THE NEW FULLY ILLUSTRATED CATALOG 402 . . .

Fully automatic. Burns gas, or oil, or both.
18 sizes ranging from 20 up to 600 b.h.p.
for pressures to 250 p.s.i. or for hot water.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 18, N.Y.

SUPERIOR
STEAM GENERATORS

CHEMICAL PROCESS INDUSTRIES:

Here's Your Guide to

For The Electrolytic Production of:

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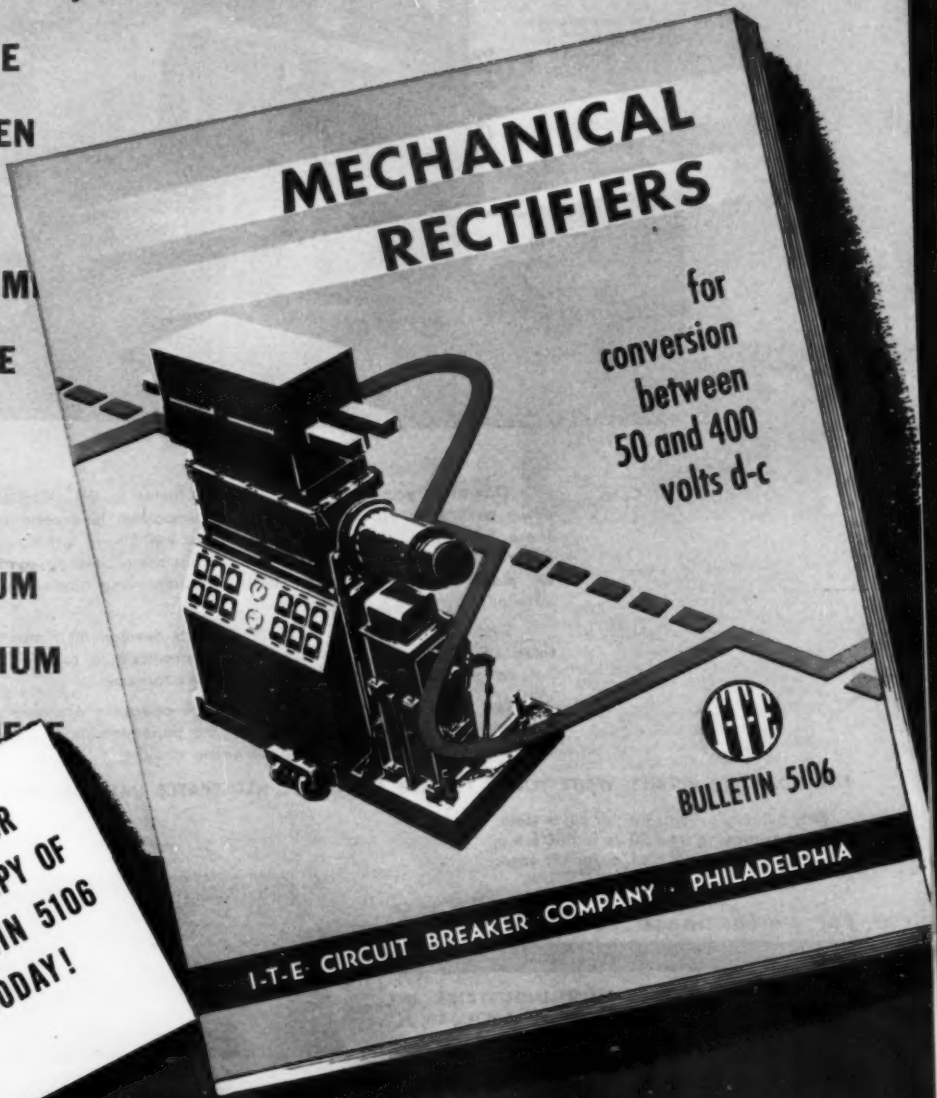
- HYDROGEN
- OXYGEN
- SODIUM M
- FLUORINE
- COPPER
- ZINC
- ALUMINUM
- MAGNESIUM
- MANGANE



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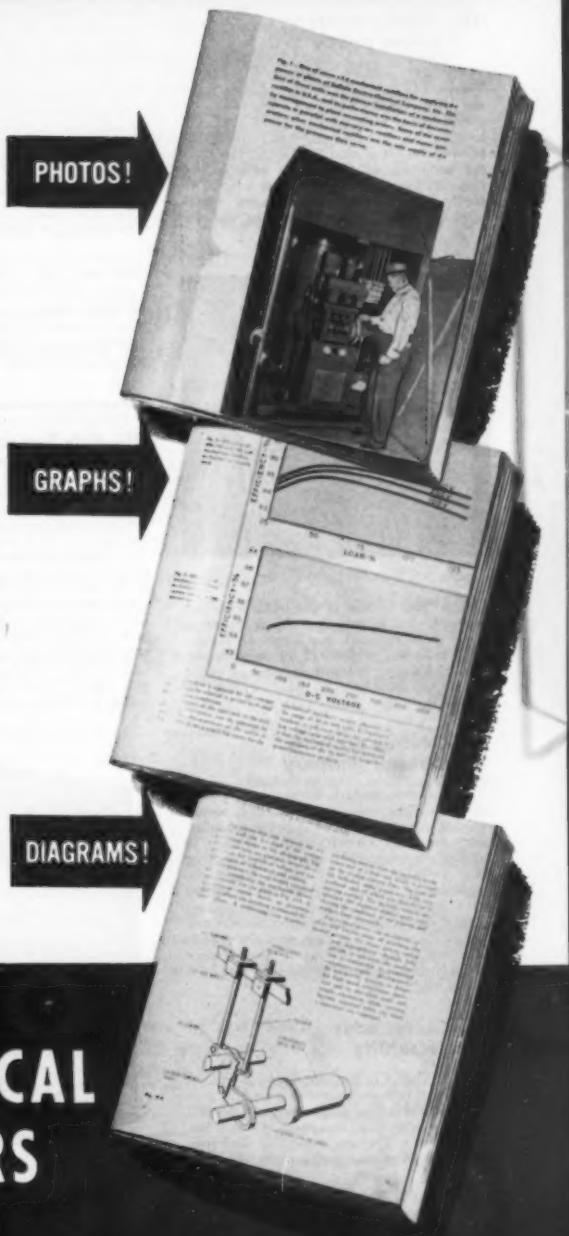
More Efficient Power Conversion

How you can get *95 to 97 per cent rectifying efficiency* for electrolytic production of chemicals at 3000 amperes and up is told in I-T-E Bulletin 5106.

Here is the story of the I-T-E Mechanical Rectifier—how it offers you direct current at lower cost; how its efficiency and economies in installation, operation and maintenance will save you money all along the line. Now you can plan your cell layout the way you want it—and get all the advantages of using low d-c voltages—greater safety to personnel —lower leakage losses to ground.

This comprehensive 32-page bulletin is packed with informative charts, diagrams and illustrations explaining the Mechanical Rectifier's operation.

Bulletin 5106 is yours for the asking. Send for it today. I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.



I-T-E

MECHANICAL RECTIFIERS

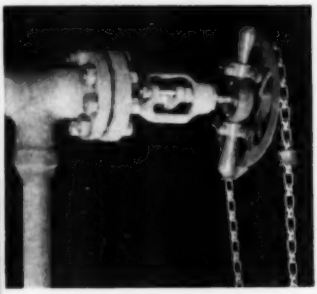
New equipment and developments

(Continued from page 16)

sistance and excellent flexibility and electrical properties make the material ideal for motor and cable insulation applications. 36 in. widths and from 4 to 10 mils in thickness are being produced.

18—Handle closes valves tightly

Impactor Handle, product of Edward Valves, Inc., has been developed to facilitate the tight closing of small chainwheel operated valves located above floor level. Delivering 2.8 times the force of conventional handwheels, it is designed so that lugs on the underside of the handle strike simultaneous blows against lugs of an adapter securely attached to the valve stem. Simultaneous blows prevent stem twist and distortion. The handle is available with two adapters of different size square openings to fit most standard size stems of various small valve makes. Sizes of the square openings, which taper towards the top, are 13/16 and 15/16 in. with total taper equal to 3/4 in. per ft.

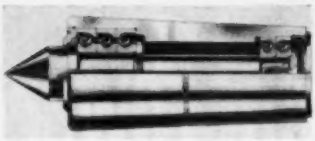


19—Coating protects exterior masonry

A clear, non-staining, water-repellent coating containing silicone resins, for porous exterior masonry surfaces is being manufactured by Preco Chemical Corp. Known as Silipruf, the material is applied by brush or spray to brick, concrete, stucco, limestone, sandstone or mortar at temperatures as low as 15 deg F. The coating has high resistance to water penetration and penetrates the surface as deep as 1/4 in., but does not change the color or texture of the surface. It does not prevent breathing, so trapped moisture may escape.

20—Center adds versatility

Ready Tool Co. has developed a line of RED-E anti-friction centers of a built-in type that eliminates overhang and permits full clearance as well as maximum distance between centers. They are assembled with precision angular contact, anti-friction ball bearings, pre-loaded and locked-in. Bearings are mounted for maximum radial and thrust load capacity. A labyrinth seal retains and preserves lubricant while shutting out contamination. These centers are recommended as replacements for the built-in type live spindle. This is accomplished by removal of the spindle bearing assembly and reboring the quill to proper taper to fit the RED-E center. Substituting a taper sleeve for the easily removed center permits use of taper shank tools in the lathe tailstock. Another advantage is that down-time for replacement of spindle bearings is eliminated.



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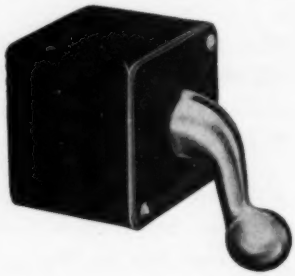
21—Gas furnace can be installed in duct work

A line of duct furnaces, designed for use in installations where the air supply and pressure orginate at a source removed from the unit, has been announced by Automatic Gas Equipment Co. Known as the "Pittsburgh" duct furnaces, they are ideal for use in air conditioning installations where the air ducts are already in place. The basic unit is equipped with a durable cast iron heat exchanger and combustion chamber to withstand corrosive effects of burning gases and moisture. Combustion chamber and heat exchanger are cast in one piece, and the extended heating surface fins on the heat exchanger are cast integral. Supplied in sizes from 12,000 to 200,000 Btu input per hour and are shipped completely assembled with controls and built-in draft diverter. A.G.A. tested and approved at 2 in. water.

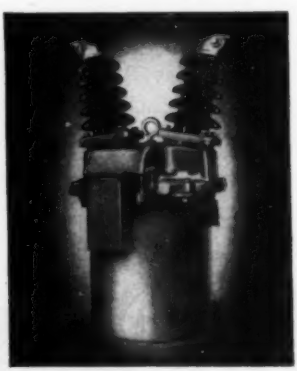
22—Drum switch for motors to 2 hp

Announcement is made by Allen-Bradley Co. of a compact reversing drum switch suitable for a wide variety of mounting arrangements for small workshops and industrial services. This drum switch is the equivalent of a three pole double throw switch. It is small, simply designed, for machines and equipment requiring an economical across-the-line starting and reversing switch for a-c and d-c motors rated at 2 hp or less. Housing of the unit is bakelite and contains 8 fixed contacts, a moving contact assembly and mounting screws. Contacts are cadmium silver alloy, eliminating maintenance. Flexibility in mounting is provided.



23—Single-pole oil switch designed for 200 amp

Single-pole oil switch, the type CSO-1, is available from the Westinghouse Electric Corp. Developed primarily for control of small banks of pole-mounted capacitors, the switch can be operated manually, or electrically by an automatic control device. Operating coils are interchangeable and provide 110-, 220-, and 440-v control. Single-pole switches can be ganged mechanically or elec-



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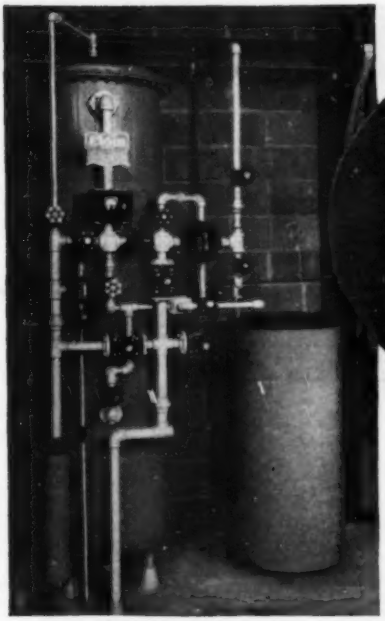


ELGIN Ultra DEIONIZER

MonoFlo Design

★ **Produces Highest Quality Mineral-Free Water**

★ **Removes All Ionizable Impurities Including CO_2 and Silica**

Replaces evaporation or distillation for as little as 1% to 10% of the cost

Check these

Ultra-Deionizer Advantages

- Replaces evaporation or distillation for almost all purposes at a fraction of the cost.
- Assures ample makeup water at all times, whereas evaporator output varies with turbine load.
- Cuts operating cost because no heat is required and there is no power loss. No costly shut-downs for cleaning.
- Any required water quality assured by automatic electronic controls.
- Prevents corrosion in boilers, turbines and feedwater systems by eliminating CO_2—thereby cutting maintenance.
- Requires far less space than evaporator equipment. Lower investment cost.

Deionized water can be used in place of evaporated or distilled water for nearly every purpose, and at as little as a hundreth to a tenth of the cost. Of equal importance is the fact that the Elgin Ultra-DeIonizer gives the highest quality water known today — water free of all ionizable impurities, including CO_2 and silica.

This remarkable single tank, mixed-bed deionizer now brings the cost of high quality demineralized water within the range of those who have heretofore found evaporated or distilled water prohibitive in cost for processing and boiler feed. Here is the perfect boiler feedwater that assures freedom from scale, silica, corrosive CO_2, carry-over, and costly blowdown.

Naturally, since the Elgin Ultra DeIonizer is of compact single-tank design, it costs far less to buy and operate, and requires but little space. It is simple in operation. Like the notable Elgin Zeolite Water Softener, it is equipped with the ingenious "Double-Check" manifold assembly, well known for its ability to increase water output as much as 44% and to protect against loss of valuable resinous exchange material.

The Elgin representative near you will be pleased to give you complete facts and figures on this remarkable equipment which is available in sizes ranging from small units delivering 5 gpm to the largest size equipment required for central station steam plants.

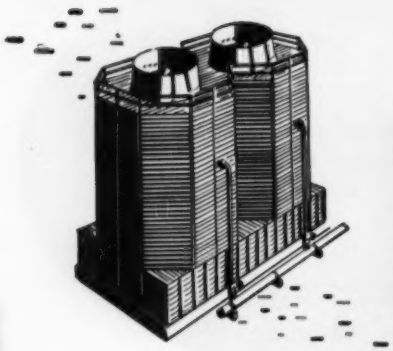
Get this bulletin Write for our NEW descriptive Bulletin 512 *which includes complete technical data.*

ELGIN Economical WATER CONDITIONING FOR EVERY NEED

ELGIN SOFTENER CORP., 138 N. Grove Ave., ELGIN, ILL.

Representatives in Principal Cities

WATER CONDITIONING SINCE 1908



FLUOR COUNTERFLO COOLING TOWERS offer many unique features — all worth looking into!

When selecting cooling towers, it pays to look into the structural and mechanical design features of a Fluor Counterflo Cooling Tower. It is here that the difference between one cooling tower and another is evident—where the difference in structural stability, maintenance of mechanical equipment, and quality appearance lies.

The illustration at right—accurate in every detail—is the way your Fluor Counterflo Cooling Tower will look with a portion of the exterior wall removed. Note the exclusives, the extras, that make Fluor Cooling Towers a wise buy. When *dependable* performance, *low* maintenance, and *quality* appearance is essential or desirable in your plant or process operations, look into a Fluor Counterflo Cooling Tower.

Fluor Counterflo Induced-Draft Cooling Towers incorporate many important design features which cut the cost of maintenance and improve the appearance of cooling equipment installations.

STACK and FAN ASSEMBLY

DRIFT ELIMINATORS

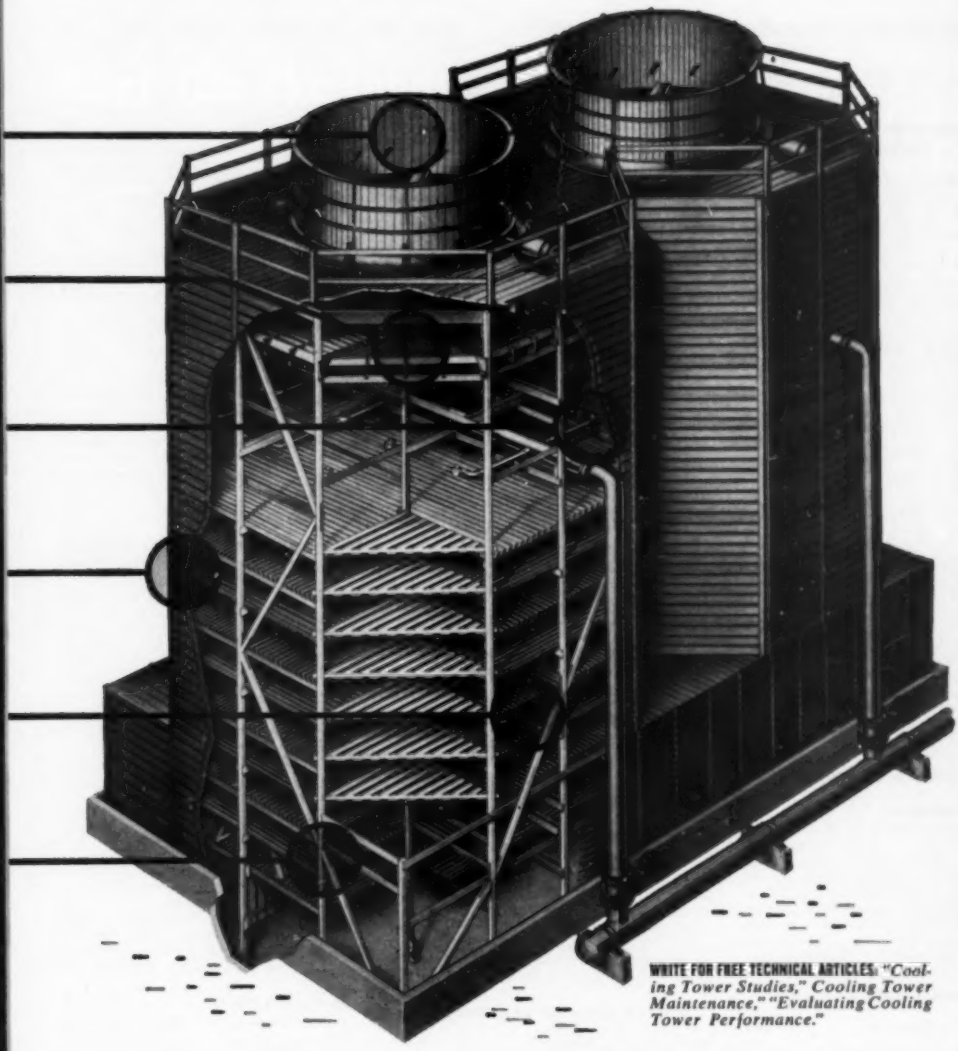
DISTRIBUTING SYSTEM

DOUBLE-WALL SHEATHING

GRID DECKS

TOWER STRUCTURE

BE SURE WITH **FLUOR**



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New bulletins and catalogs

Literature on engineering products and developments

Each new bulletin item has a key number for your convenience in asking for a free, personal copy. Insert key numbers on return post card found on page 133

ANTI-CORROSIVE & PROTECTIVE COATINGS

Asphalt Coating **200**

Brochure, 4 pages, gives detailed application data and lists uses of weatherproof, mineral-armored asphalt. Includes specifications, application data, approximate costs, and illustrated, detailed information regarding equipment used in applying. American Bitumuls & Asphalt Co.

Paint-anchoring Treatment **201**

Paint-anchoring corrosion-resistant phosphate treatment for metals is described in 8-page booklet. Details the common causes of paint failure and how they can be prevented, then goes into methods of application—immersion and spraying—of the treatment. Lists typical uses. Octagon Process, Inc.

Specialty Coatings **202**

Four page technical folder contains quick reference index to determine most suitable coatings for rust prevention, chemical corrosion, and dampness. The Wilbur & Williams Co.

Rusted Metal Primer **203**

"Worried About Rust" is a 4-page folder that tells how metal primer applied directly over rusted surfaces, stops rust and primes metal for paint. Advantages, prices, containers and other information are covered. Rusticide Products Co.

BATTERIES & CHARGERS

Battery Maintenance **204**

Data sheets show how to return to full service motive power storage batteries which have lost capacity due to the formation of lead sulphate on the positive and negative plates. The 2-page sheet gives 6 causes of sulphation and details 11 steps to follow to restore batteries having various degrees of sulphation. Gould-National Batteries, Inc.

COAL, ASH & BULK HANDLING

Belt Conveyer Carriers **205**

Belt conveyer carriers are the subject of 20-page bulletin 2C. Complete information on types for practically any bulk material handling application is given. Lists features, applications, sizes and dimensions of each style along with lubrication and maintenance data. Photographs, cutaways and drawings show full particulars of the units. Stephens-Adamson Mfg. Co.

Hopper Conveyer **206**

Literature describes conveyer designed for filling hoppers on spreader or underfeed stokers where increased capacity has been provided by extending sides of hopper. Lists advantages, applications, dimensions and specifications. New London Engineering Co.

Ash Handling **207**

"Modern Ash Handling for Modern Power Plants" is a 4-page brochure describing ash handling systems in four recently completed plants. Pumping, jetting and pneumatic methods are briefly discussed. The Allen-Sherman-Hoff Co.

Coal Handling **208**

Ideas and suggestions for solving the coal and ash handling problems of today's power plants are presented as part of 44-page book 2410. Also contains

helpful layout drawings and photographs of actual installations at both large and small public utility, industrial and public building power plants. Installations at new plants as well as boiler houses that were modernized, enlarged or improved after the original installation also are shown. Includes sections on unloading coal, auxiliary unloading, coal storage and reclaiming, crushers, transporting and distributing equipment, ash handling, and water intake screens. Link-Belt Co.

BOILERS & BOILER ACCESSORIES

Boiler Service Valves **209**

Surface blow, bottom blow-off, water column blow-off and connections are thoroughly covered in 22-page bulletin E125. Describes quick-opening and slow-opening straighway valves, angle valves, Y valves and duplex blow-off units, with complete specifications, materials of construction and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of valve operation. Section also describes valves for fire protection. Everlasting Valve Co.

Boiler Accessories **210**

Line of alarms, gages, trycocks and accessories described in 16-page catalog 700. Well illustrated with photographs, dimensional drawings and cross sections. Complete specifications and data given for a large variety of sizes and pressures. Easy to use illustrated index for quick reference. Wright-Austin Co.

Water Columns & Gages **211**

Complete details on recent improvement made in high-pressure gage glass inserts are contained in 20-page bulletin WG1811 (revised). Gives full information on operation, construction features, design advantages, typical arrangements, dimensions and accessories. Cutaways, diagrams, and drawings illustrate features of the units. Photographs show typical installations. Arrangements of reflecting mirrors are diagrammed and discussed. Yarnall-Waring Co.

BUILDING HEATING, VENTILATING & AIR CONDITIONING & REFRIGERATION

Controls **212**

Complete and informative 48-page catalog F1753-3 describes thermostats, motor-operated valves and accessories for heating, ventilating, and air conditioning applications. Combines engineering data with selection information which should aid in choosing automatic electric control equipment. Barber-Colman Co.

BUILDING MATERIALS & MAINTENANCE

Mortar **213**

Discussing the importance of narrow, tight joints in obtaining long life where corrosive conditions exist, 4-page bulletin E27 tells how floors with joints down to ⅛ in. can be installed by using readily flowable, non-shrink mortar produced with Embeco. Gives complete specifications. The Master Builders Co.

Fluorescent Ballasts **214**

Two publications on fluorescent lamp ballasts are offered. The first, 20-page booklet GEA5731, explains in non-technical language how a fluorescent lamp works and the part the ballast plays in its operation. Illustrated with diagrams, the book reviews the role of the ballast in modern fluorescent lighting. Of a more technical nature, the second publication, 4-page GEA5672 deals with G-E's system of "sound-rating" its ballasts. Describes how ballasts are classified according to the amount of natural hum they emit. Ex-

(Continued on page 28)

DIAMOND
SOOT BLOWERS

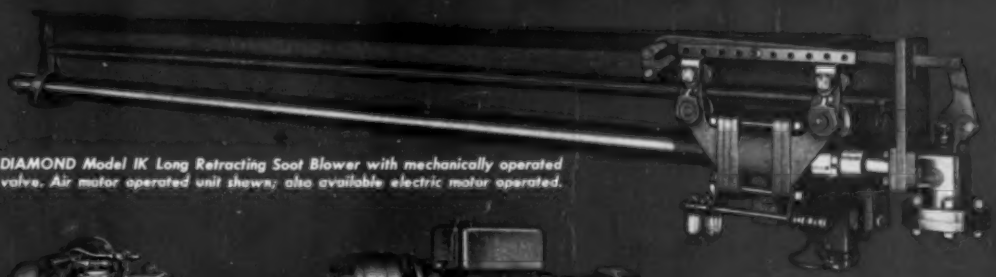
Meet the challenge of HIGH BOILER AVAILABILITY

The greater emphasis being placed on high boiler availability indicates the equal importance of high soot blower availability. The first can be limited by the second.

No other power plant equipment takes the "beating" to which soot blowers are daily subjected. Elements are exposed to repeated, sudden and severe thermal shock . . . to extremes of temperature, erosion and corrosion.

Diamond has long paid particular attention to "high availability" in its research . . . in the design, in the selection of materials and in the manufacture of all Diamond Soot Blowers. That they excel in this direction also is attested by their performance records . . . and by the preference they have long enjoyed among the most critical users of boiler equipment. The next time you need soot blowers, it will pay you well to select Diamond Soot Blowers.

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited · Windsor, Ontario



DIAMOND Model IK Long Retracting Soot Blower with mechanically operated valve. Air motor operated unit shown; also available electric motor operated.

DIAMOND Model IR Short Retracting Soot Blower. Electric operation shown; also available for manual or air operation.

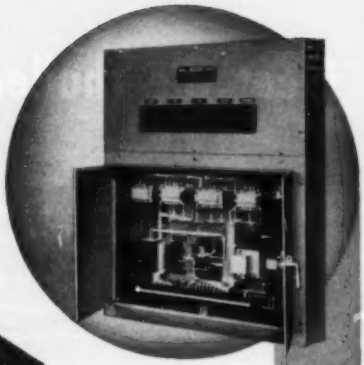
DIAMOND Model A2E Automatic Air Puff Soot Blower.

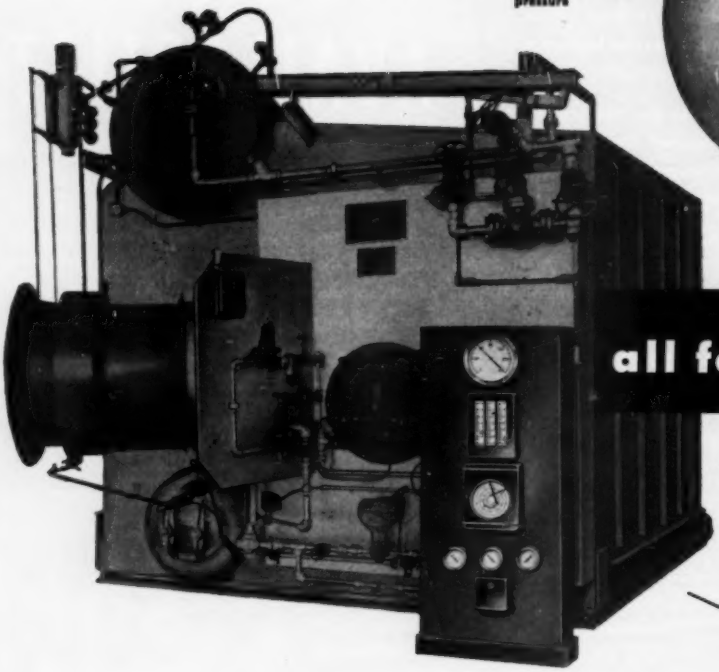
DIAMOND Model G9B Soot Blower. Air operation shown; also available for manual or electric operation.

There is a DIAMOND Soot Blower . . . for Every Boiler Cleaning Requirement

FULLY AUTOMATIC

- push-button start
- operation at all pressures up to design pressure





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SEMI-AUTOMATIC

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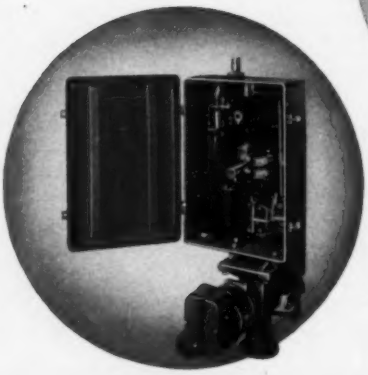
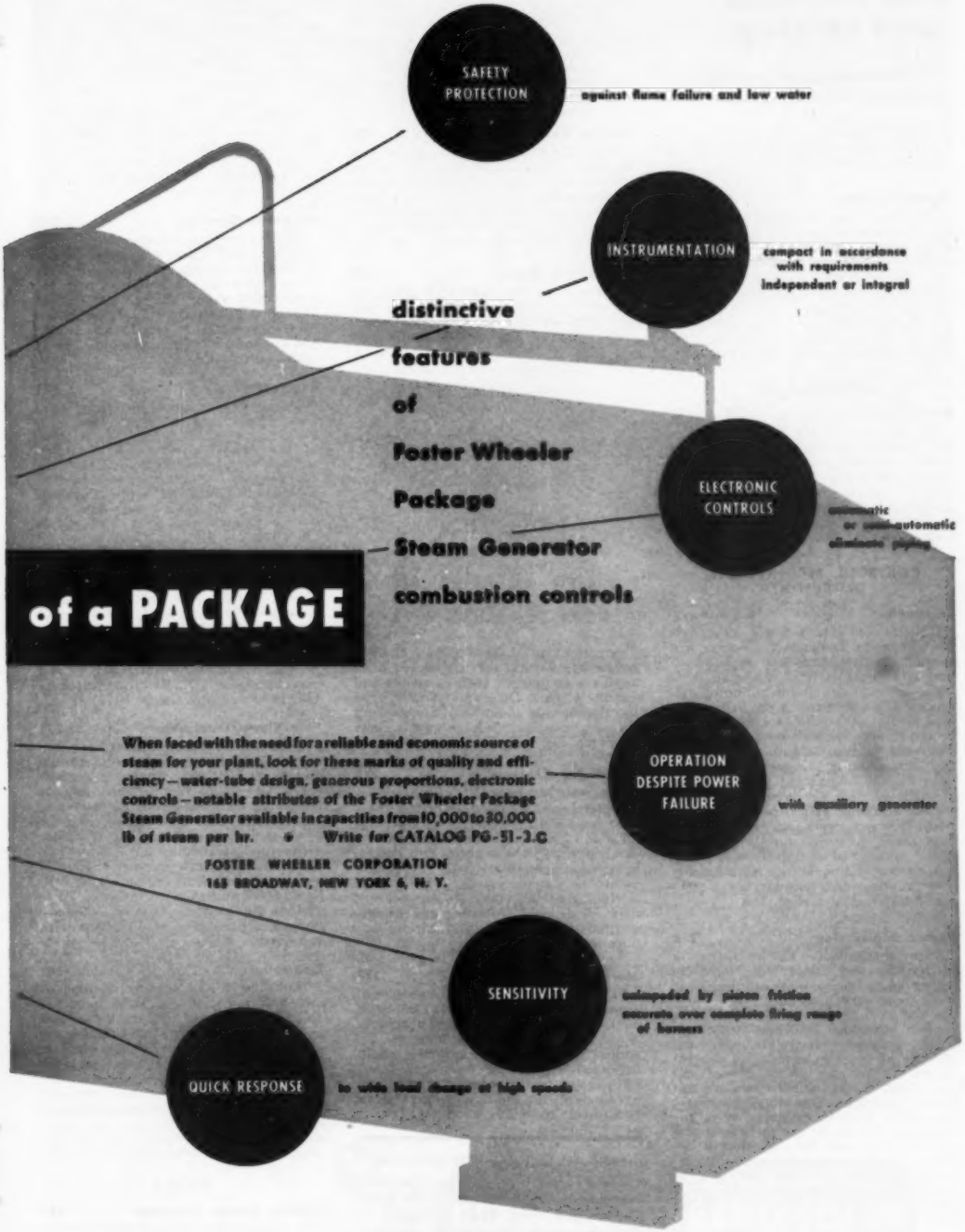
- wide operating range
- modulating control

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When faced with the need for a reliable and economic source of steam for your plant, look for these marks of quality and efficiency -- water-tube design, generous proportions, electronic controls -- notable attributes of the Foster Wheeler Package Steam Generator available in capacities from 10,000 to 30,000 lb of steam per hr. • Write for CATALOG PG-51-2.C
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OPERATION DESPITE POWER FAILURE
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unimpeded by piston friction
accurate over complete firing range of burners
QUICK RESPONSE
to wide load change at high speeds
FOSTER WHEELER

New bulletins and catalogs

(Continued from page 24)

plains how these ratings can be put to use, and gives a typical example of application. General Electric Co.

Water Repellent **215**

Technical treatise 126-11 on the use of silicone base materials to make masonry walls water repellent contains a study of the water repellency problem and outlines the tremendous annual damage caused by absorption of water into masonry surfaces. It discusses preventive methods and emphasizes the use of silicones for this purpose. Test data is presented. The Monroe Co.,Inc.

COMPRESSORS

Rotary Compressors **216**

Advantages of the rotary principle in producing compressed air are set forth in 4-page bulletin C6. Also explains operating features which are said to cut down maintenance time. Cross section drawings and typical installation photographs illustrate the booklet. Fuller Co.

CONTROLS, REGULATORS & INSTRUMENTS

Telemeters **217**

Bulletin 230-H4, 8 pages, describes the Chronoflo Telemeter, which makes possible the transmission of information and controls over a simple two-wire electrical circuit for unlimited distances. Lists features of the device, describes the operation of transmitter and receiver, and shows photographs and diagrams to illustrate the mechanism and installations. Suggested applications for the instrument include measurement of flow of liquids and gases through Venturi tubes, nozzles or orifices; flow over weirs, through Parshall flumes and Kennison nozzles; proportional control of chemical feed, pump control, and liquid level measurement; also pressure and temperature metering. Builders-Providence, Inc.

System Engineering **218**

"Servomechanism Techniques in Modern System Engineering" is a 22-page pocket-size booklet outlining basic facts about servomechanism techniques for the analysis of industrial process control systems. Information is presented in elementary style, assuming little or no prior knowledge of control theory on the part of the reader and avoiding mathematical equations entirely. Diagrams show simple examples of various control systems. Lists advantages offered by the technique and explains the need for cooperation between instrument companies and users. Concludes that potential benefits far outweigh design and application difficulties. Minneapolis-Honeywell Regulator Co., Industrial Div.

Measuring System **219**

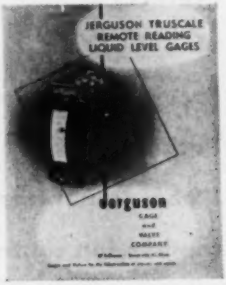
Application of fluid pressure measuring system in oil and chemical processing for automatic control, remote indicating and recording, is featured in 4-page bulletin. Covers the principles of bonded resistance wire strain gage and pressure cells; electrical transmission of pressure variations; elimination of explosion hazard; and system accuracy. Baldwin-Lima-Hamilton Corp.

Control Units **220**

Catalog 8000, 16 pages, illustrates and describes vane type electric contact control units used with limit type signalling and control instruments, to give snap-action on-off, two or three position control. Minneapolis-Honeywell Regulator Co., Brown Instrument Div.

Liquid Level Gages **221**

Remote reading liquid level gages are featured in 8-page bulletin 176. Advantages and applications are listed. Tells how the unit operates and shows



illustrations of three standard models covering pressures up to 1500 psi. Lists auxiliary equipment such as visible and audible alarms. Diagrams show typical installation and mounting. Engineering specifications included. Jerguson Gage & Valve Co.

Positioning Controls **222**

Illustrated bulletin C-1 fully describes completely pneumatic gear-driven operator for throttling control service. Applicable to heavy-duty services such as catalyst slide valves, large gate valves, heavy dampers, blast gate valves and Saunders patent valves. The 8-page booklet contains complete engineering data describing features, dimensions, methods of operation, and various applications. Conoflow Corp.

Meter-relay Controls **223**

Illustrated bulletin G51 shows line of automatic contact meter-relay controls, controlling pyrometers and accessory equipment. The 4-page bulletin describes design features and lists applications. Illustrates three types of meter-relays and two types of controlling pyrometers in addition to accessory equipment. Assembly Products, Inc.

HOW TO REQUEST FREE BULLETINS

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Control System **224**

Catalog S196C is profusely illustrated with photographs, flow diagrams, dimensional drawings, performance charts and specification tables. The 12-page booklet describes control valves, pressure master controls, desuperheaters, temperature master controls, water regulating valves, liquid level and drainage controls, differential pressure controls, feedwater heaters, feedwater regulators, separators, exhaust heads, air separators, and other accessories. The Swartwout Co.

Automatic Controls **225**

Line of automatic pressure, temperature, level and flow controls is presented in 100-page catalog 53G (revised). Full information on each type of instrument is provided along with a great deal of data in tabular form on ranges, capacities, specifications, etc. Photographs and dimension drawings included. General Controls Co.

Regulators **226**

Design advantages of line of pressure and temperature regulators are explained in 4-page bulletin 1007. Sectional view shows the pilot, seats and discs, springs, metal diaphragm and packless construction. Another illustration shows how main valve can be combined with two pilots to form two regulators having different functions. Spence Engineering Co., Inc.

Gages & Thermometers **227**

Large variety of recording, dial indicating, transformer and freezer thermometers and pressure, vacuum and compound recording gages fully described and illustrated in 8-page bulletin G143C. Also 4 pages of operating instructions for recording gages, and complete price list. Electric Auto-Lite Co., Instrument & Gauge Div.

Flow Signal Transmitter **228**

Bulletin 2551, 8 pages, describes pneumatically operated pressure-differential measuring unit that transmits proportional signals to remote recording or indicating instruments, or to automatic control elements. The signals may be linear with flow or linear with pressure differential, according to the booklet. Diagrams illustrate seven suggested uses in measurement of flow, liquid fuel, liquid level, and absolute pressure. Lists various applications. Cutaway drawing illustrates principles of operation. Hagan Corp.

Controllers **229**

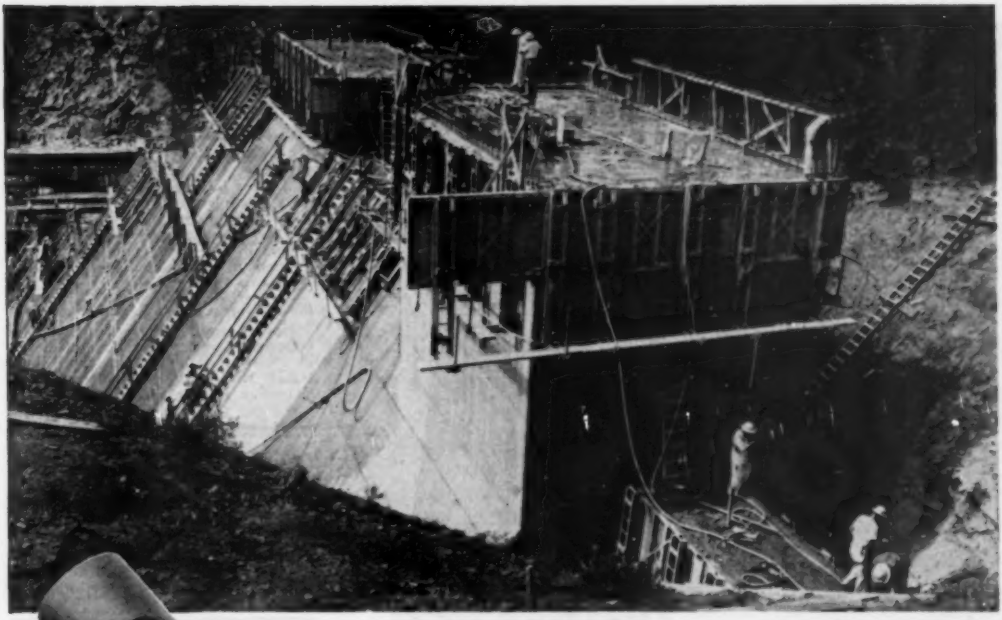
Illustrations and descriptive material on special fabrication services, inmersed coil and direct fired heaters, bolted and welded steel tanks, walkways and stairways are contained in 20-page catalog. Section on control equipment includes diaphragm control valves, displacement type liquid level controllers, pressure controllers, drainers, self-operated and relay regulators, safety-heads, and pressure-vacuum vent valves with flame arrestors. Black, Sivalls & Bryson, Inc.

DIESELS

Cooling System Treatment **230**

Protection of engine cooling systems through proper water treatment is the subject of 4-page bulletin 5015. Covers

(Continued on page 30)



Philpott Dam finds solution to difficult Water and Air Hose problems

● Air and water hose, used in the Philpott Dam construction, came up against every enemy in the book. Changeable Virginia weather weakened hose resistance to high pressure loads, abrasive concrete structures clawed away hose covers, and the rocky terrain made deep, stabbing, carcass-penetrating wounds that caused sudden breakdown and work stoppage.

Ordinary hose wouldn't meet these challenges. Engineers, faced with rigid work schedules, couldn't put up with interruptions. They called in the local Republic Rubber Distributor, who, after a thorough study of all hose hazards, recommended use of Republic's Champion Air Hose and Republic's Champion Water Hose.

9,000 feet of these standard-built (not custom-made) pressure carriers went into immediate action for Philpott engineers who say Republic hose eliminated work stoppages and cut maintenance costs to absolute minimum.

Republic Rubber Products produce results like this for men in every industry. There's a complete line of Hose, Belting, Packing and Molded & Extruded Products. Just drop us a card regarding any one of these products.

CHAMPION AIR DRILL HOSE

A super service hose of braided construction on oil-resistant tube, a strong flexible carcass and shock-resisting cover.

CHAMPION WATER HOSE

Top quality hose of wrapped construction, built with specially reinforced carcass, a smooth, friction-reducing tube and a rugged outer cover that provides maximum protection against external damages.

INDUSTRIAL RUBBER PRODUCTS BY

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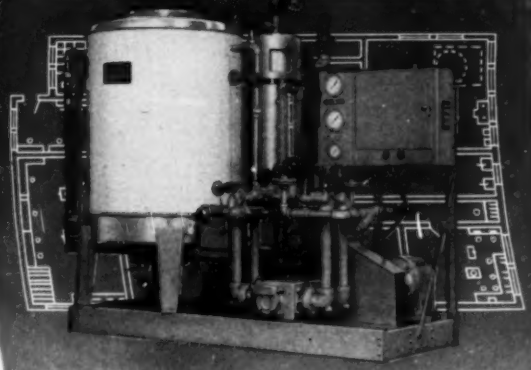
MORE STEAM
Faster and at Less Cost



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FORCED RECIRCULATION
STEAM GENERATORS

Plan your steam plant for long range economy and realize immediate savings on installation and operating costs.

The Clayton *Forced Recirculation* Steam Generator...in sizes from 15 to 100 h.p., and equipped to burn gas or oil, or both...is a compact, self-contained steam plant ready to install and operate as it is delivered. No accessories to buy. No stack, bricking or foundations to install. Move into place; connect fuel and water lines, electricity and vent, and the Clayton generator is ready to operate. Occupies 30% to 70% less space than conventional boilers of same capacity.

Within 5 minutes from a cold start, the Clayton generator attains full operating pressure. Any fluctuating load demand within its rated capacity is instantly and automatically met. No standby losses. High thermal efficiency cuts fuel costs in half, or better. On gas fired units, new electronic safety control proves the flame pilot; automatically shuts down plant on ignition failure or loss of fire. Clayton generators are built to conform to the A.S.M.E. Boiler Code, and are Hartford inspected. Send the coupon for complete catalog.

The coupon below brings a convincing demonstration to your desk.

STEAM PLANT OPERATORS *Mail this coupon*

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Send name of nearest distributor and arrange desk demonstration of Clayton Forced Recirculation principle. Send catalog.

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Animated flow chart shows how Forced Recirculation principle cuts steam costs.

New bulletins and catalogs

(Continued from page 28)

the prevention of corrosion of diesel and other internal combustion engines. Gives complete coverage of the necessity for water treatment, chromate control in closed systems, application of treatment and dosages as well as test methods in determining concentrations. Dearborn Chemical Co.

Diesel Engines **231**

House organ describes actual case histories of the performance of diesels in a variety of applications. Well illustrated with installation photographs. Cummins Engine Co., Inc.

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Engines **232**

Design, operation and engineering data on 4-cycle engine built for diesel, dual fuel and spark-fired gas operation, are presented in 12-page bulletin 191. Contains actual comparative test data showing advantages of the unit, principal of which are increased horsepower and thermal efficiency which is said to result in more horsepower hours per gallon of fuel and lubricating oil. Diagrams show the more common types of cooling systems applicable to the engine and presents a nomogram for determining the bmep rating under typical operating conditions. Available in sizes from 425 to 3200 bhp. Installation photographs portray some applications. Nordberg Mfg. Co.

ELECTRICAL DISTRIBUTION

Rotary Packet Switches **233**

Structure, operation and advantages of rotary packet switches are presented in 12-page illustrated bulletin. Shows in detail the many combinations available and provides engineering data, ratings, dimensions and mountings. The Arrow-Hart & Hegeman Electric Co.

Selenium Rectifiers **234**

Advantages of metallic, dry cell, selenium rectifiers are listed in 4-page bulletin. Supplies a long list of suggested industrial applications for the individual cells in a variety of sizes or as complete stacks. Shows various circuit arrangements and gives cell sizes and ratings. Syntron Co.

Mechanical Rectifiers **235**

Mechanical rectifiers for conversion between 50 and 400 v d-c are thoroughly covered in 32-page bulletin 5106. Full information is given as to just what

(Continued on page 156)

Oil Burner Performance Revolutionized by

Coppus-Dennis FANMIX® Action

Jet reaction of steam-atomized oil is utilized in Coppus-Dennis FANMIX Oil Burners to rotate a fan which is an integral part of the burner. The air delivered by the fan is forced through a sheet of atomized oil, discharged from jets on a rotating disc. An ideal mixture for fast, complete combustion and peak efficiency is thus created.

FIELD-TESTED FOR MORE THAN 2 YEARS

Thoroughly proved in important installations for more than two years, these unique burners have proved profitable investments wherever used. In one of its plants, the American Woolen Company equipped two 1000 hp boilers with six Coppus-Dennis FANMIX Oil Burners.

In Terre Haute, Indiana, Type DC FANMIX Oil Burners were installed early in 1948 on two fully automatic 250 hp steam generators in the Commercial Solvents Corporation plant. They were supplemented by a third FANMIX Oil Burner when another boiler was installed.

ONLY FANMIX OIL BURNERS GIVE YOU ALL 6 FEATURES

1. **INCREASED BOILER RATINGS.** All your furnace is used for combustion, none for mixing. You get higher unit heat releases.
2. **STEPPED UP FUEL EFFICIENCY.** Complete combustion guaranteed with 5% to 10% excess air.
3. **NO "HOT SPOTS."** Continuous explosion kills torch action and disperses heat uniformly throughout furnace.
4. **FORCED DRAFT EQUIPMENT ELIMINATED.** FANMIX action overcomes entire draft loss across burners. No blowers, duct work needed.
5. **STACK REQUIREMENTS CUT** in new installations. Boiler ratings increased with your present stack. Forced draft created by FANMIX action requires less furnace draft.
6. **COKING OF ATOMIZERS REDUCED.** Tips air cooled by fan blades to point well below coking temperature. Less downtime, lower maintenance costs.

ANOTHER COPPUS "BLUE RIBBON" PRODUCT

IT WILL PAY YOU to learn the full details on why Coppus-Dennis FANMIX Oil Burners, made to Coppus "Blue Ribbon" standards of quality, promise superior performance. Send coupon today.

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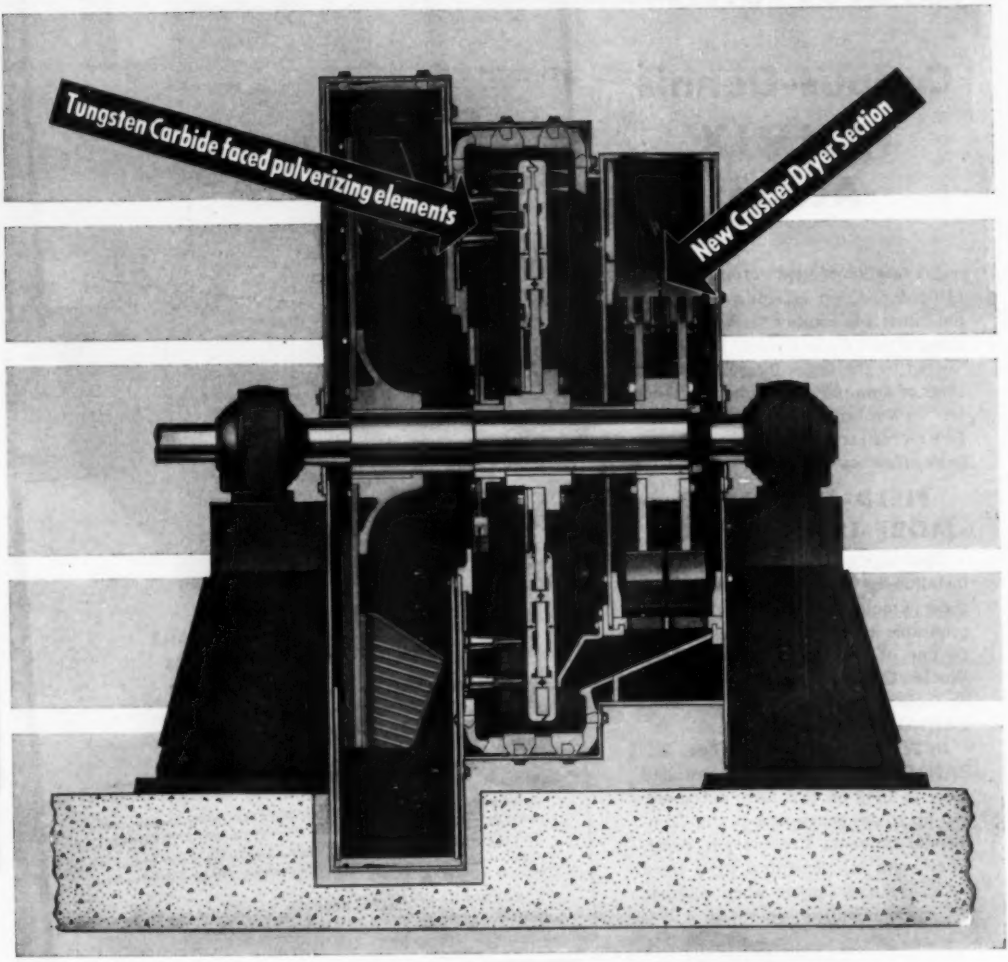
This new Riley Pulverizer gives you



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STOKER CORPORATION, WORCESTER, MASS.

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Cincinnati Atlanta New Orleans St. Louis Kansas City St. Paul Tulsa Houston Denver
Salt Lake City Los Angeles Portland Seattle

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • FLUE GAS SCRUBBERS

these added significant advantages

No capacity reduction with increase in moisture.

In the crusher dryer section where coal is crushed to a fine granular state, approximately 40% through a 50 mesh screen, representing about 5% of the work to be done, free moisture is evaporated from coal. The crusher dryer section acts as a flash dryer. Coal then enters pulverizing section where 95% of the work is done, completely free of moisture which would affect pulverizer performance and capacity. The crusher dryer section is designed with ample capacity for the highest moisture coals and as moisture is evaporated before coal enters the pulverizing section, moisture has no effect on pulverizer capacity or performance.

Tramp iron, iron pyrites and other foreign materials in coal rejected.

The crusher section of the pulverizer rejects tramp iron, iron pyrites and other hard foreign substances in the coal, preventing any materials from entering the pulverizer section which could cause damage.

Pulverizing elements faced with tungsten carbide.

Pulverizing elements are faced with tungsten carbide, assuring long periods of service without outage for maintenance and resultant low maintenance costs. Numbers of Riley pulverizers equipped with tungsten carbide faced parts have been in operation over two years without showing appreciable signs of wear, indicating at least several additional years of service before replacements are necessary. Over 70,000 tons of coal have been pulverized by a mill having a six-ton per hour capacity with indications that well over 200,000 tons will be pulverized before requiring replacement.

Fineness sustained over years of operation.

Because the life of the tungsten carbide faced pulverizing elements is so long, fineness of pulverization is maintained over years of operation. Tests on existing installations show no falling off of fineness after over two years of operation. No adjustments are necessary to maintain fineness.

Unusually high capacity per unit of space.

The improved Riley pulverizers have an unusually high capacity per unit of floor space and height, permitting their installation under crowded space conditions. A Riley Pulverizer having a capacity of 20 tons per hour with 50 grindability high moisture coal is only 11'9" wide, 10'0" deep and 7'6" high and weighs only 46,780 lbs. Because of their lower weight and quiet vibrationless operation, heavy foundations are not required.

If you are interested in coal pulverizers, we believe you will find the article "THE USE OF TUNGSTEN CARBIDE IN COAL PULVERIZERS," presented at the fall meeting of the A.S.M.E., well worth reading. We will be happy to mail a copy to you without charge on request.

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

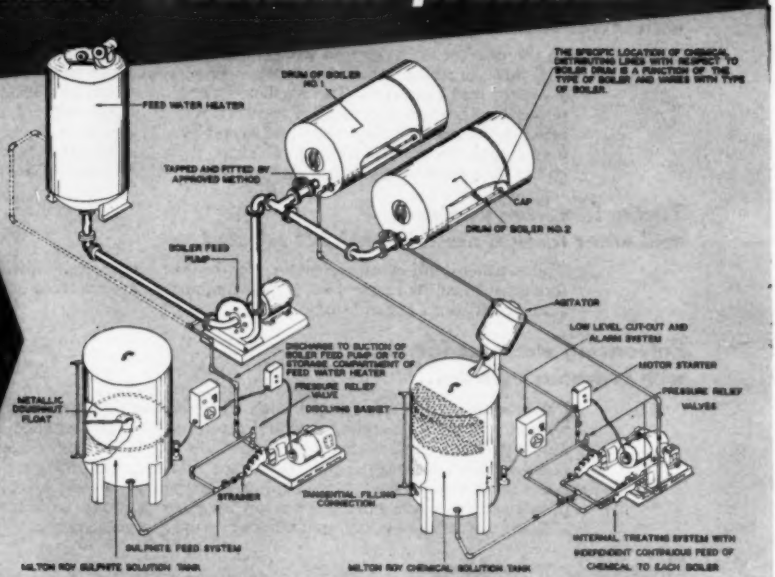
COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

Here's a sure "system" for beating boiler water treatment problems!

IT'S A TYPICAL MILTON ROY "PACKAGED" SYSTEM FOR BOILER WATER TREATMENT


FEED WATER HEATER
DRUM OF BOILER NO. 1
DRUM OF BOILER NO. 2
CAP
TAPPED AND FITTED BY APPROVED METHOD
BOILER FEED PUMP
AGITATOR
LOW LEVEL CUT-OUT AND ALARM SYSTEM
MOTOR STARTER
PRESSURE RELIEF VALVES
METALLIC DISCHARGE FLOAT
PRESSURE RELIEF VALVE
DISCHARGE TO SUCTION OF BOILER FEED PUMP OR TO STORAGE COMPARTMENT OF FEED WATER HEATER
DISSOLVING BASKET
STRAINER
TANGENTIAL FILLING CONNECTION
SULPHITE FEED SYSTEM
MILTON ROY SULPHITE SOLUTION TANK
MILTON ROY CHEMICAL SOLUTION TANK
INTERNAL TREATING SYSTEM WITH INDEPENDENT CONTINUOUS FEED OF CHEMICAL TO EACH BOILER

IN these days of insistence on production efficiency, engineers turn to Milton Roy for *dependable* continuous treatment of boiler feed water. Here are just a few reasons why:

Milton Roy automatic "packaged" systems are engineered by specialists in Controlled Volume Pumping. The use of Milton Roy Controlled Volume Pumps in these systems is positive assurance of precision control and metering of chemicals at any pressure requirement. The patented non-clogging liquid end step-valve design of these pumps contributes materially to the efficiency of the system. Power plants and public utilities, both large and small, attest the record of uninterrupted service supplied by Milton Roy pumps and equipment.

These packaged systems are custom engineered to specifications. All necessary accessory equipment is supplied—solution tanks, covers, gage glasses, low-level cut-outs and alarms, motor starters and agitators as needed. Obvious benefits result from using one source of supply.

Milton Roy supplies systems for internal and external water treatment to handle all treating chemicals to meet all capacity and pressure requirements. Write to our engineers for complete information.

WITH THE EXCLUSIVE STEP-VALVE DESIGN

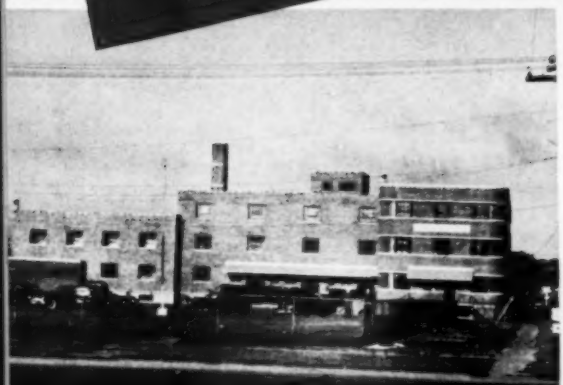
MILTON Roy COMPANY

1319 EAST MERMAID LANE, PHILADELPHIA 18, PA.

MANUFACTURERS OF CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

Now more important than ever to you...

Fast LOCAL delivery



Convenient LOCAL warehouses

On-the-spot LOCAL lubrication engineering

Standard's LOCAL Lubrication service

• Wherever you are located in the Midwest, there's a Standard service-supply center close at hand. That means prompt delivery of Standard products, immediate assistance from a Standard lubrication specialist.

There's no need to worry over possible production delays due to lack of the right cutting oil, lubricant, or fuel . . . no need to stock-pile these supplies in your own plant . . . no need to wait for help in solving your lubrication problems.

To take advantage of Standard's time-saving *local* lubrication service (now more important than ever to you) call the Standard office in your area. Or write: Standard Oil Company (Ind.), 910 South Michigan Avenue, Chicago 80, Ill.

STANDARD OIL COMPANY STANDARD (INDIANA)

What's YOUR problem?

D. G. Cripps, of Standard Oil's Grand Rapids, Michigan, office, is the Standard Oil lubrication specialist who recommended STANOIL for use in the hydraulic press shown at the left.

Complete familiarity with job requirements and lubrication applications equips a corps of such Standard Oil lubrication specialists throughout the Midwest to handle similar problems for plant operators.

One of these lubrication specialists is near your plant – ready to give you the benefit of his experience and training. You can obtain his services quickly and easily. Just phone or drop a card to the nearest Standard Oil Company (Indiana) office. Ask the lubrication specialist to explain the benefits of such widely accepted lubricants as:

SUPERLA Greases—Available in all consistency grades, SUPERLA Greases cover a wide range of applications. These products are comparable in quality to the highest type of special greases but are as readily available and economical as ordinary cup greases.

CALUMET Viscous Lubricants—On open gears and wire rope, these greases strongly resist washing and throw-off. Their superior wetting ability affords better coating of gears and chains, better internal lubrication of wire rope.

STANORUST Rust Preventives—The eight grades of STANORUST form one of the most complete and effective lines of rust preventives on the market today. Each has been scientifically and specifically developed for its intended use. The grades range from a finger print remover to a heavy petrolatum that protects against corrosion for years under the most severe outdoor exposure.

Gain these benefits for your hydraulic operations

The big 400-ton hydraulic press shown above is used to stamp out parts for farm machinery in a big midwest plant.

When the press was first put into operation, plant operators followed the recommendation of a Standard Oil lubrication specialist and used STANOIL Industrial Oil in the hydraulic system. In over four years of continuous hard service, there has been no lost time because of inefficient performance of the hydraulic oil.

Oil capacity of the system is approximately 9 barrels; only 2 barrels make-up per year has been required. The oil in this system has never been changed. It has been centrifuged once to remove moisture which accumulated over three years' operation. Periodic tests of oil samples have shown that STANOIL has maintained its high lubricating quality. A recent analysis showed no increase in viscosity of the oil, no change in color, and a neutralization number of only 0.13 mg. KOH/gm.

You can rely on this unique many-purpose oil to give you the same clean, dependable service in your plant's hydraulic systems, speed reducers, head stock gears, auxiliary turbines, compressors, and electric motors. You can rely, too, on the expert, on-the-spot service of a Standard Oil lubrication specialist. How you can obtain his help, quickly and easily, is explained at the right.

STANOIL
TRADE MARK
Industrial Oil

Standard Oil Company, 910 So. Michigan, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)

STANDARD

CHROMALOX *gives you* the LOW COST answer

for

CHROMALOX

all-metal electric radiant heaters

Get all the advantages of infrared heat and more—at a fraction of former costs with the new and improved CHROMALOX heating principle. All-metal construction, high heat intensity, infrared radiation that's "color blind" and heat that's infinitely variable, have proved CHROMALOX Radiant Heaters superior for over 300 different uses in more than 1500 plants. If you use heat for baking, drying, preheating, curing, degreasing and similar applications, CHROMALOX Radiant Heaters can very likely give more satisfactory results. See for yourself how these infrared units up output, improve uniformity, reduce costs.

CHROMALOX

Electric Heat for Modern Industry

Time, money and material saving applications

FOR MORE INFORMATION
CHECK, CLIP AND MAIL COUPON

PLASTICS
- ☐ Drying powders
- ☐ Drying Cellophane
- ☐ Preheating strips
- ☐ Preheating cloth
- ☐ Curing vinyl
- ☐ Post-forming
- ☐ Curing tubing

METALS
- ☐ Heating molds
- ☐ Degreasing
- ☐ Paint baking
- ☐ Drying piston rings
- ☐ Baking wrinkle paint
- ☐ Welding preheating
- ☐ Drying automotive parts
- ☐ Preheating steel rolls
- ☐ Dehydrating refrigeration coils

GLASS
- ☐ Drying bottles
- ☐ Heating safety glass
- ☐ Setting dye on glass cloth
- ☐ Preheating lenses
- ☐ Drying mirrors

ELECTRICAL
- ☐ Baking armatures
- ☐ Drying marine equipment
- ☐ Sealing headlights and television tubes
- ☐ Drying varnished wire
- ☐ Drying carbon resistors
- ☐ Drying color coding

FOUNDRIES
- ☐ Drying sand cores
- ☐ Skin drying of molds
- ☐ Comfort heating

FOOD
- ☐ Warming
- ☐ Drying baking pans
- ☐ Dehydrating crackers
- ☐ Baking biscuits
- ☐ Dehydrating coconuts

TEXTILES
- ☐ Dehydrating braided material
- ☐ Drying Nylon thread
- ☐ Dehydrating woolen cloth
- ☐ Setting flock

RUBBER
- ☐ Curing
- ☐ Heating rubber glue
- ☐ Curing latex

PRINTING
- ☐ Ink drying
- ☐ Static elimination
- ☐ Glue drying
- ☐ Drying varnished paper
- ☐ Silk screen drying

CERAMICS
- ☐ Drying frit
- ☐ Drying glaze
- ☐ Drying pottery

MISCELLANEOUS
- ☐ Sealing storage batteries
- ☐ Setting adhesives and cements
- ☐ Curing tobacco
- ☐ Melting wax
- ☐ Drying photographic negatives and prints
- ☐ Dehydrating kraft paper

and many other Applications

EDWIN L. WIEGAND CO. Radiant Heater Division
7520 Thomas Boulevard, Pittsburgh 8, Pa.

I am interested in infrared heat for_____

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- ☐ Send me application file on uses I have listed.
- ☐ Ask factory representative to contact me.
- ☐ Send Chromalox Catalog on Industrial Heaters.

Name_____
Company_____
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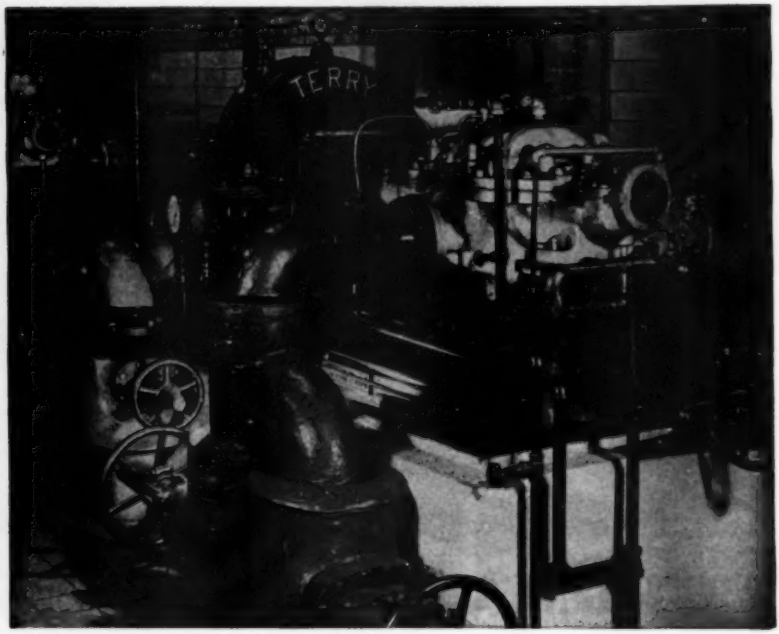
TERRY



110hp Feed Pump Turbine with Large Safe Clearances

The blades of this turbine are milled out of a one-piece forged-steel wheel with generous clearance both radially and axially. The side clearance is very large — one inch — and the blades are protected by a projecting rim on each side of the wheel. It is therefore impossible for the blades to foul and end play can do no damage to the turbine.

These are but a few of the features that make the Terry Solid-Wheel Turbine such a dependable driver. A bulletin giving other interesting facts about this turbine will be sent upon request.

T 1179

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

FLEXINEERING

PENFLEX'S ANSWER TO YOUR FLEXIBLE TUBING PROBLEMS

An extra man to help you plan new products requiring flexible tubing or to solve problems on old products. That's the service Penflex's "Flexineering" offers you. Flexineering is the scientific application of the right size, weight and type of flexible tubing on the right installation or product to assure the longest life with the greatest efficiency.

Coast to coast . . . border to border, Penflex installations prove the value of "Flexineering."

When you require tubing or hose that is as tight as a pipe but flexible, safe at high temperatures . . . free from metal fatigue . . . specify Penflex.

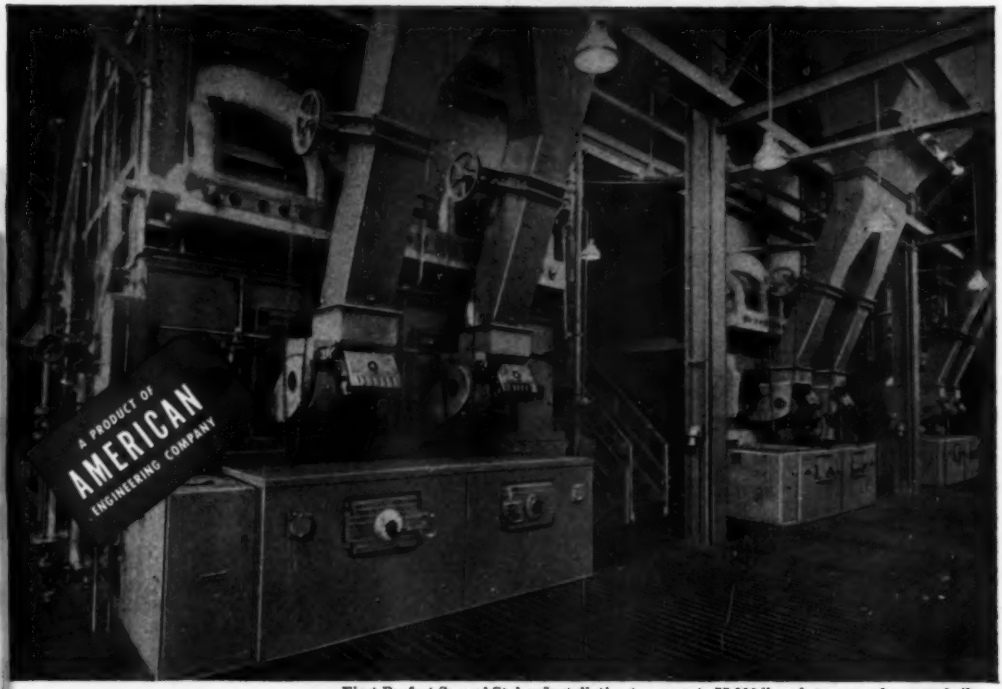
Penflex manufactures a complete line of four wall interlocked and seamless welded corrugated flexible tubing in sizes from 1/8" to 30" I.D. Write today for your copy of "Flexineering."

Pennsylvania Flexible Metallic Tubing Company, Inc., 7238 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: **Boston • New York • Chicago • Houston • Cleveland • Los Angeles**

penflex

HEART OF INDUSTRY'S LIFE LINES

1... 2... and now a 3rd order for



First Perfect Spread Stoker Installation to generate 55,000 lbs. of steam per hour per boiler.

Day and night, for weeks at a time, Spreader Stoker continuously releases 700,000 B.T.U. per hour per square foot of active grate area

1 IN THE FALL of 1949 a very well known corporation installed three AE Perfect Spread Stokers to generate 55,000 lbs. of steam per hour each in one of its midwest plants.

2 Months later the Company needed more steam from larger boilers in another plant where the existing stokers had been designed to burn 12,300 B.T.U. per pound coal. Over the years, however, the available coal dropped to as low as 9500 B.T.U. per pound so the plant could not carry the required load.

On the basis of proved performance, an AE Perfect Spread Stoker was installed as a replacement... and here's the record:

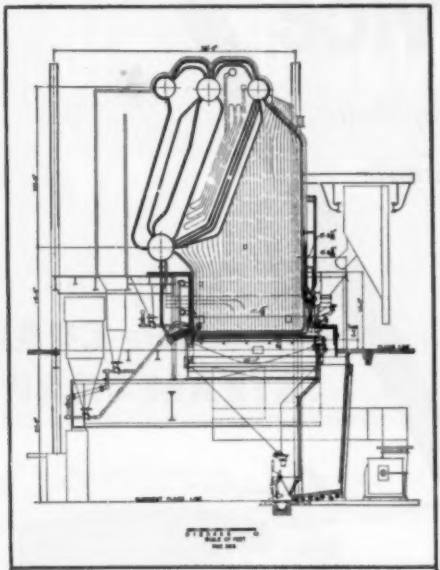
The Perfect Spread has averaged better than 180,000 lbs. of steam per hour—24 hours a day—7 days a week for weeks on end. Efficiency is about 84% and the release rate exceeds 700,000 B.T.U. per sq. ft. of active grate area per hour! In terms of sustained results per sq. ft. of grate surface this is probably the highest duty spreader stoker installation in the world. With an increased manufacturing load they now find they can carry 200,000 lbs. per hour.

3 And now, again on the basis of performance, the same company has ordered two more duplicate Perfect Spread Stokers.*

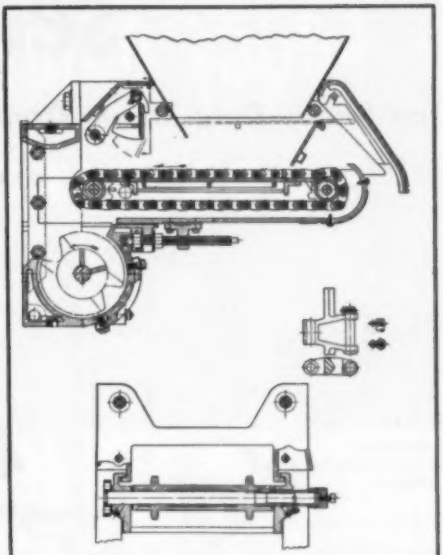
AE Perfect Spread Stokers burn high and low ash coals with practically equal efficiency. They assure positive, continuous coal feed and unbe-

*AS THIS MESSAGE WAS GOING TO PRESS, THE ABOVE COMPANY PLACED A FOURTH ORDER FOR A PERFECT SPREAD STOKER.

PERFECT SPREAD STOKERS



Second larger installation of Perfect Spread Stoker actually giving 200,000 lbs. of steam per hour from a single boiler.



NON-CLOGGING CONVEYOR FEEDER: Coal enters feeder from hopper, and is conveyed positively, continuously and uniformly forward. Coal is not fed in slugs.

lieveably even distribution. *They never clog on wet coal.*

Perfect Spread Stokers have a capacity range from 8,000 to 500,000 lbs. of steam per hour... coal feeders are adjustable from 50 lbs. to 7500 lbs. of coal per hour. Mail coupon today for a copy of the Perfect Spread Stoker booklet and for a reprint of a new report on large spreader stokers. Also, if you are now considering a boiler in capacities from 300,000 to 500,000 lbs. of steam per hour, let's arrange to get together and discuss cross-firing.

WON'T CLOG ON WET COAL

AE

AMERICAN ENGINEERING

COMPANY

PHILADELPHIA 25, PENNA.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

American Engineering Company
2400 Aramingo Avenue
Philadelphia 25, Penna.

Gentlemen: Kindly send me free copy of Perfect Spread Stoker booklet and new stoker report ☐. I should like to discuss cross-firing ☐.

Name_____ Title_____

Company_____

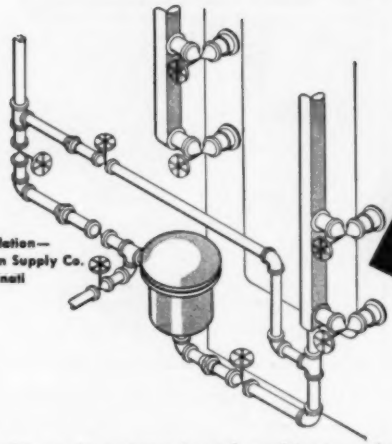
Address_____

City_____ Zone____ State____

for outstanding service

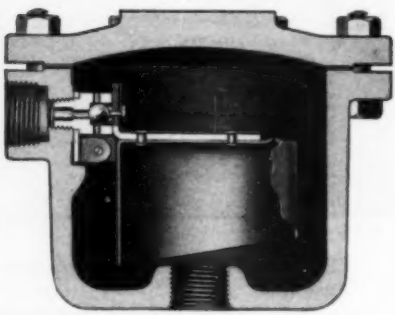
on Heavy-Duty Steam Drying Units

...for example



The installation—
American Linen Supply Co.
Cincinnati

Rely on Dependable CRANE STEAM TRAPS



Crane Inverted Open Float Steam Trap with patented ball-type disc, for 1 to 300 pounds saturated steam working pressures. Literature on request from your Crane Branch or Crane Wholesaler.

PROBLEM: To equip a steam-heated tumbler-type drier with a trap that would reduce start-up time to a minimum, and provide, automatically, a smooth, steady flow of hot, dry steam to the unit, with the lowest possible maintenance cost.

WORKING CONDITIONS: Steam pressure to drier, 125 pounds. Drier operated 16 hours daily on continuous batch basis.

SOLUTION TO PROBLEM: Crane No. 981, ¾-inch, 150-Pound Inverted Open Float Trap, carefully selected for adequate drainage capacity, and properly installed. (Now listed as No. 9810, with patented improved ball-type disc.)

RESULTS: Never requiring any repairs or new parts in more than 8 years' service, this Crane trap has given complete satisfaction. Periodic routine inspection only is total maintenance cost.

...ANOTHER TYPICAL CASE HISTORY demonstrating the better performance... the lower ultimate cost of Crane Valves of all types... and why—
More Crane Valves are used than any other make!

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

are you spending $5664

TO DO A $1417 JOB?

A Chicago plant* was! Oil consumption for their 5 high speed machines ran to $5664 a year . . . yet machine break-downs and bearing replacements were frequent . . . stock spoilage and rejects were high —until they made an important 30 day lubrication test.

This test involved the installation of an *Alemite Centralized Lubrication System* on a single mammoth machine. After a month of daily cost checks and comparisons, the system was installed on all five other machines in the plant at a total cost of only $2471. Since that time, there has not been a single break-down or bearing loss, stock spoilage and rejects have been greatly reduced, and lubricant cost has been cut to $1417. Net savings from this company's smart investment: $4247 annually. The net result: more production gained from each machine, marked product improvement, increased customer satisfaction!

Call Your Alemite Lubrication Engineer

No matter what size or type of plant you operate, Alemite can show you dozens of ways to save through the more efficient handling of petroleum products. Call your local Alemite Industrial Distributor now or send for the free booklet "11 Ways to Cut Production Costs." Simply attach the coupon below to your letterhead. Dept. M-121, 1850 Diversey Parkway, Chicago 14, Illinois.

*Name on request.

ALEMITE

REG. U.S. PAT. OFF.

MEANS EVERYTHING FOR LUBRICATION

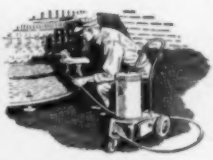
1. Methods 2. Lubricants 3. Equipment

Another Product of Stewart-Warner

Alemite Cuts Costs 3 Ways

1. In transferring lubricants... cuts man hours 63% for every 100 pounds transferred. No mess, no contamination.

2. In loading grease guns . . . saves 3¾ man hours for every 100 pounds of lubricant loaded into hand guns.



3. In applying lubricants . . . saves up to 23.9 man hours for every 100 pounds of lubricant applied to bearings.

FREE! Valuable booklet— "11 Ways to Cut Production Cost"

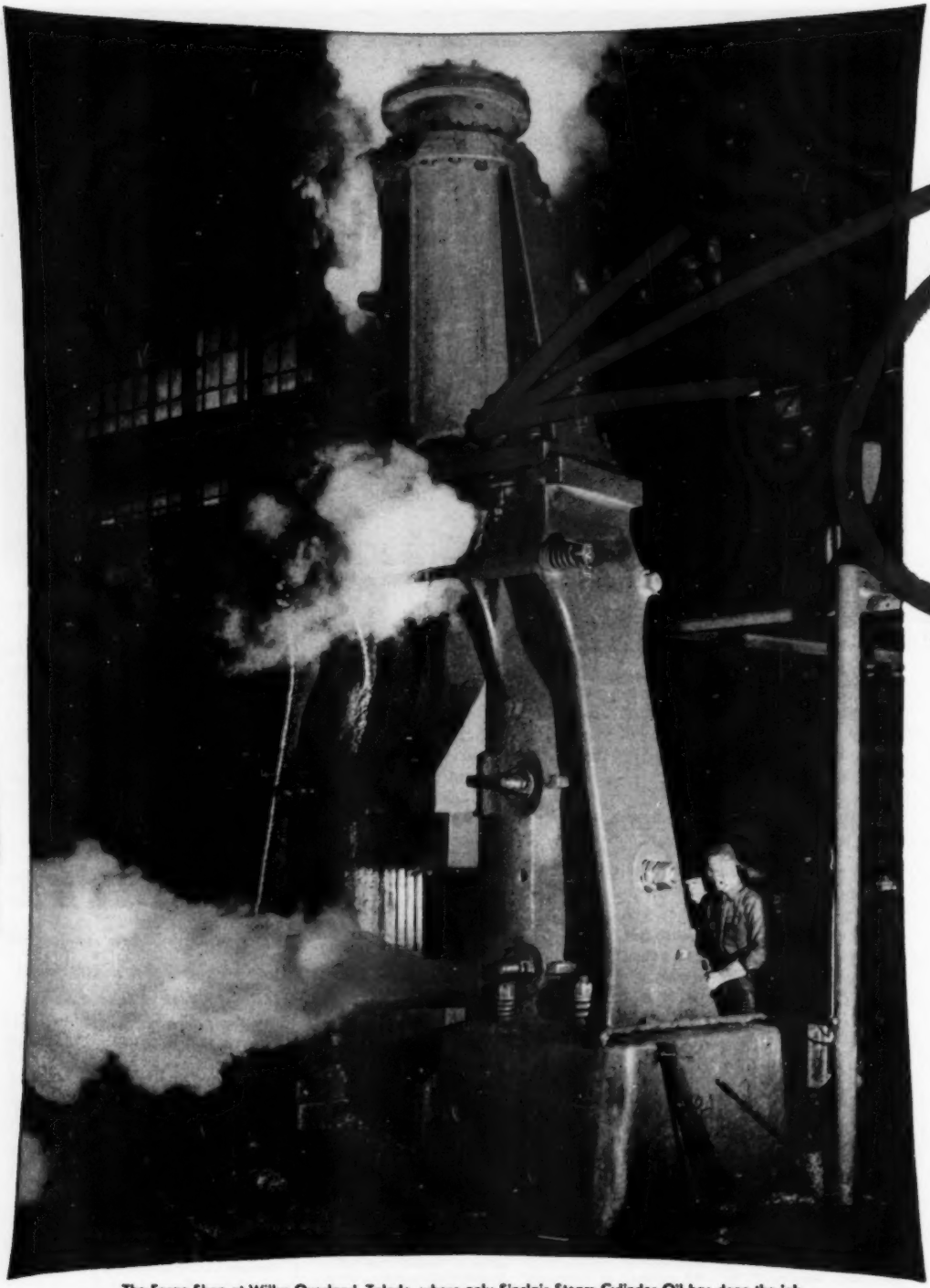
Simply attach this coupon to your letterhead and we'll include facts on the new Alemite Oil-Mist System, too—OIL-MIST atomizes oil into mist, circulates it to bearings under pressure. Increases life of bearings as much as 17½ times.

ALEMITE, Dept. M-121
1850 Diversey Parkway, Chicago 14, Ill.

Name .....

Company .....

City ..... State .....



The Forge Shop at Willys-Overland, Toledo, where only Sinclair Steam Cylinder Oil has done the job.

"NO OTHER OIL has done this Job!"

reports Willys-Overland Forge

Mr. Wm. Paris, Vice President in Charge of Manufacturing at Willys-Overland Motors, Inc. says, "We have saved plenty of cylinders, packing, and down-time since shifting to Sinclair lubrication."

Rising production forced the mammoth Forge Shop at Willys-Overland to step up ram speed 30%. As the power was insufficient, the steam had to be raised to 400°F. by superheating. Then the lubrication problem started!

The hotter steam and faster ram speed quickly burned up packings, and cylinders became scored. Many lubricants were tried. All failed to halt the destruction... until the Forge tried Sinclair Valve Oil Light. Now it reports it hardly ever has a scored cylinder and no more lubrication headaches. The Forge does not believe it possible to get finer steam cylinder lubrication and emphatically concludes that, "No other oil has done this job!"

If you have a steam cylinder lubrication problem it can pay you to consult with Sinclair, for Sinclair makes a wide variety of Steam Cylinder Oils to handle every possible need. Get in touch with your nearest Sinclair Representative or write Sinclair Refining Company, 600 Fifth Ave., New York 20, N. Y.

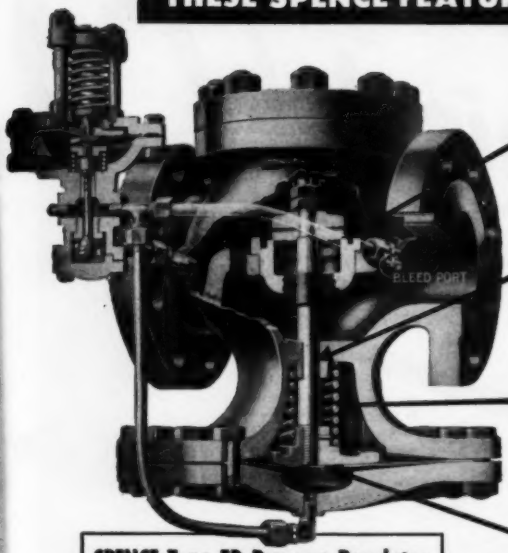
SINCLAIR STEAM CYLINDER OILS

for every steam cylinder installation

HERE'S PROOF

You Can Cut Costs of Pressure and Temperature Control

THESE SPENCE FEATURES SHOW YOU HOW



SPENCE Type ED Pressure Regulator

SECO METAL SEATS AND DISCS — Durable SECO Metal resists wiredrawing. *More than twenty years of experience* in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

PACKLESS CONSTRUCTION — All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . eliminates much time-consuming maintenance.

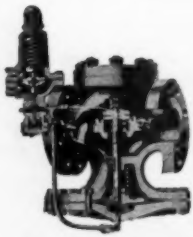
SPRING OUT OF PATH OF STEAM — The spring in the Spence Regulator is out of the path of the steam or other fluid flowing through the valve. It operates at low unit stress for exceptionally long life.

LARGE BALANCED DIAPHRAGM—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.

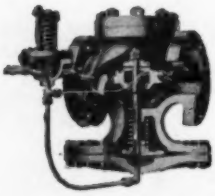
YOU BENEFIT by these and many other Spence features that assure *accurate, dependable* regulation year after year. That means *less down-time, less time and money wasted on replacement of parts.*

Spence Pressure and Temperature Regulators are built in sizes from *¼" to 12"* for service with *air, steam, water, oil or gas.* Only minor adjustments are needed to switch any Spence Regulator from one service to another.

Type BT150 Temperature Regulator—Tops in performance for both storage and instantaneous heaters.



Type EN Differential Regulator—Accurately controls differential between fluid delivered by regulator and some other source of pressure connected to the pilot spring chamber.



Type EQ Back Pressure Regulator — Completely packless, pilot operated for accurate control of the initial pressure.

These Companies Have Profited with SPENCE!

The Springs Cotton Mills
Ford Motor Company
Pennsylvania Power & Light Company
Jones & Laughlin Steel Corporation
National Tube Company
The Atlantic Refining Company
Great Lakes Steel Corporation
Todd Shipyards Corporation
Land O'Lakes Creameries, Inc.
General Electric Company
R. J. Reynolds Tobacco Company
Ohio Edison Company

and thousands of others

SPENCE ENGINEERING COMPANY INC.
WALDEN, NEW YORK

Spence

SCHRAMM
STATIONARY COMPRESSORS

For over a half century SCHRAMM INC., has devoted its entire resources exclusively to the manufacture of air compressors. This background and experience is reflected in the complete package featured here.

In addition to furnishing the size compressor, the correct type drive and mounting to fill every industrial requirement, you can also get all of the necessary accessories for a complete installation. Available in a compact package, easy to install and capable of furnishing 24-hour continuous service.

Built in sizes ranging from ½ to 100 horsepower.
Write for Booklet C-50B.

COMPLETE PACKAGE
EASY TO INSTALL

SCHRAMM INC.
The Compressor People
WEST CHESTER, PENNSYLVANIA

SCHRAMM, INC., WEST CHESTER, PA.

Please send Free Booklet C-50B on installing Stationary Air Compressors.

Name_____

Title_____

Company_____

Street_____

City_____ Zone_____ State_____

Prest-O-Lite
Trade-Mark

dissolved ACETYLENE

in small tanks for SOLDERING, HEATING, LIGHT BRAZING

because...

PREST-O-LITE Gas Tanks are built to quality standards even beyond government specifications. This means extra resistance to dents, punctures, and corrosion—an extra measure of ruggedness that pays off in added years of economical service.

because...

PREST-O-LITE Tanks are checked and serviced *every time we charge them*, under a rigid plant routine that surpasses both Federal and State fire and safety requirements.

because...

This *complete* small tank service assures you of maximum protection and convenience. It is available exclusively through authorized distributors who handle only genuine PREST-O-LITE Gas and Small Tanks.

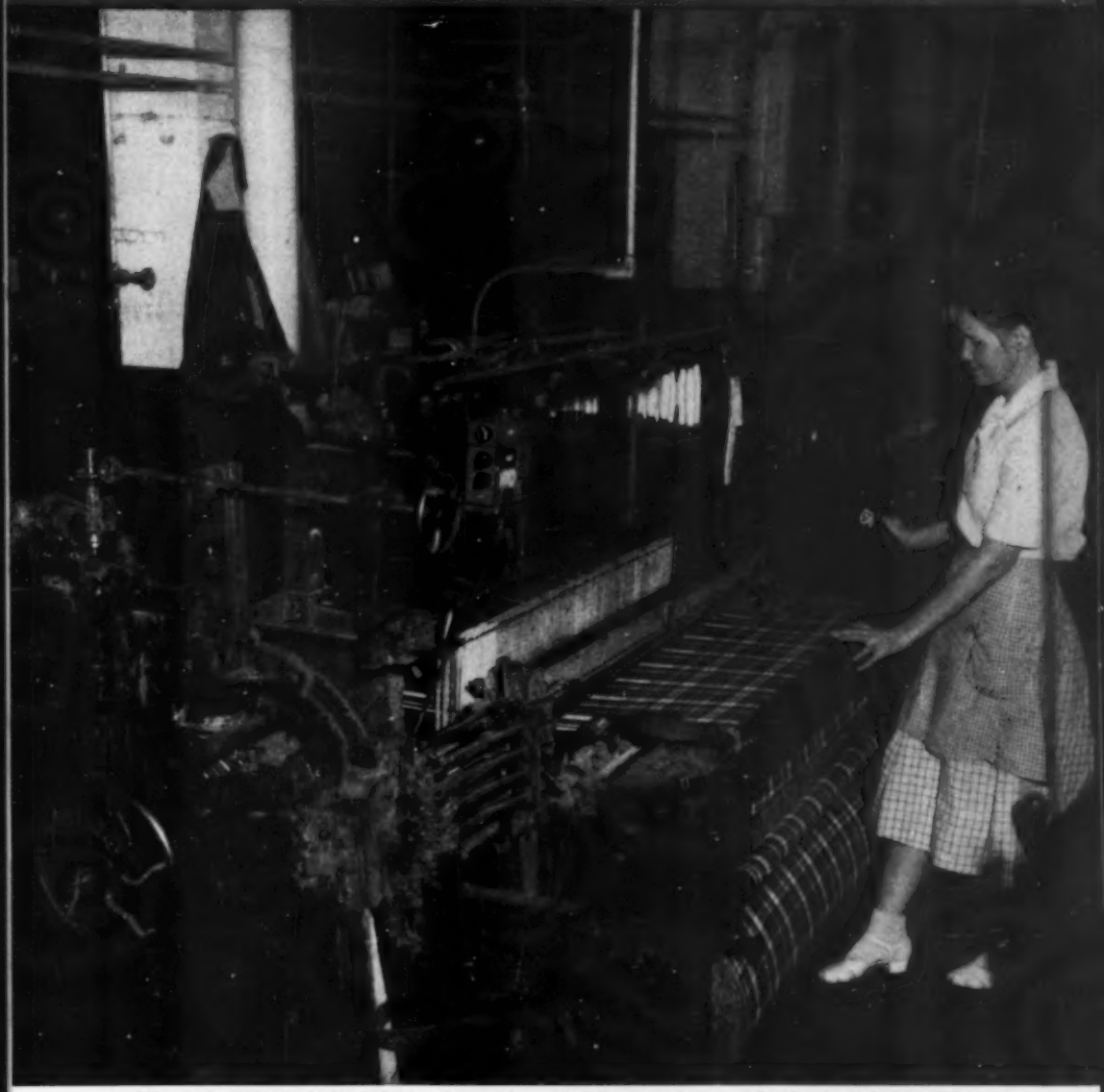
because...

PREST-O-LITE Gas is so easy to get. Thousands of authorized PREST-O-LITE Gas Service Stations throughout the country can supply new tanks or exchange full tanks for your empties. Write for addresses of those near you. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd St., New York 17, N. Y.

PREST-O-LITE Gas is available in two convenient sizes of steel tanks: MC Tank (left) holds 10 cubic feet; B Tank (right) holds 40 cubic feet.

The term "Prest-O-Lite" is a registered trade-mark of Union Carbide and Carbon Corporation.

B.F.Goodrich GROMMET BELTS AT WORK

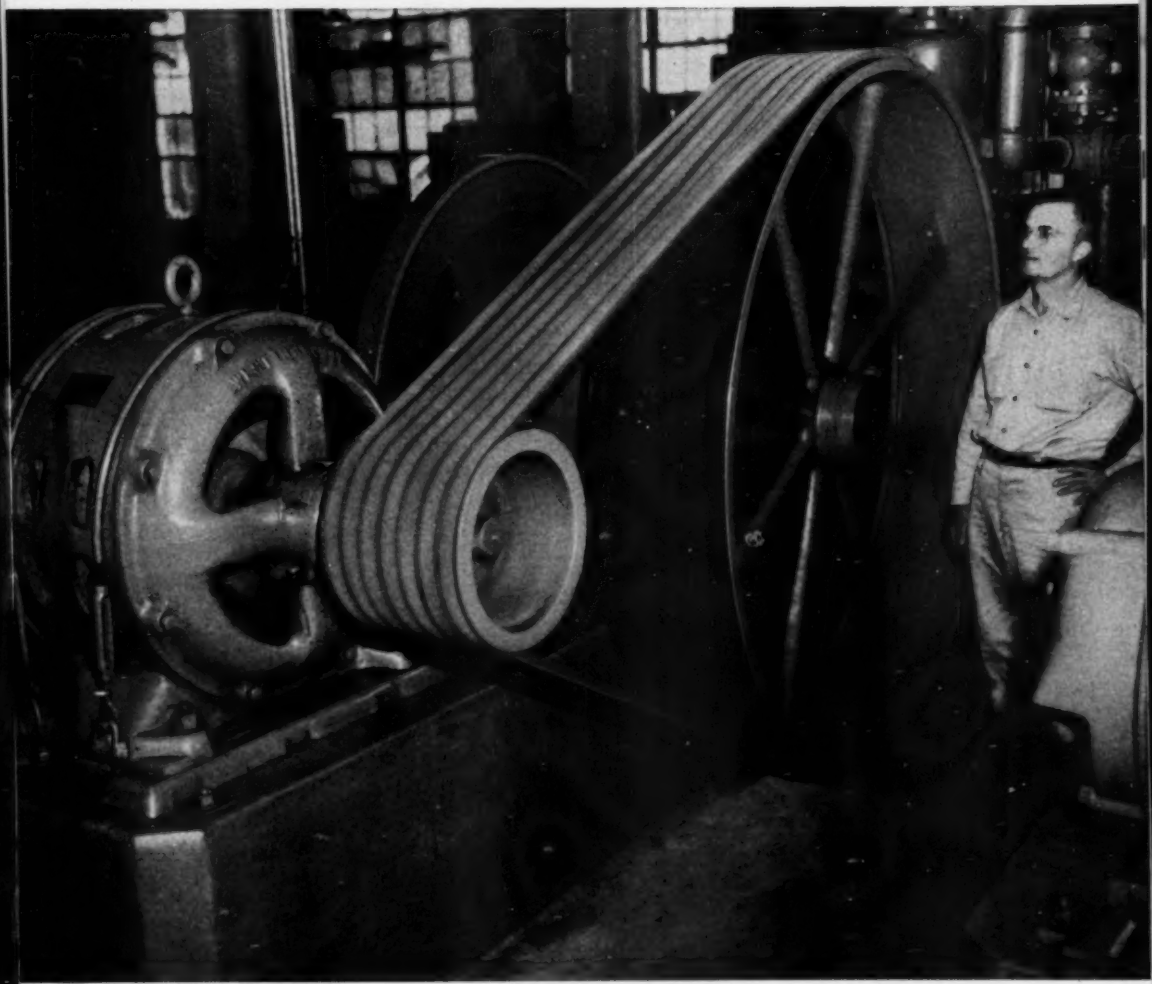


The air in this room has to be kept so damp—day and night, seven days a week—that it might as well be raining.

It's always wet weather

Here's a place that has to be very damp so that threads won't snap. It's a weaving shed in a cotton mill. The machine used for "making weather" (shown on next page) is driven by V belts and runs all the time. But dampness and constant use were too much for ordinary belts. They wore out before their time. An entirely new kind of belt was needed. To find out how this problem was solved, see the following pages.

Wet weather (continued)



Sit down, mister, for 10 years. That's probably how long he'll have to wait for trouble even though these belts run 24 hours a day.

B. F. Goodrich grommet V belts solved the problem described on the preceding page. When this picture was taken, the grommet belts had been running for eight years. Engineers who checked them said they looked good for two years more. That would be 2½ times as long as the old-type belts.

Here's why B. F. Goodrich grommet V belts carry heavier loads, withstand more shocks and last longer than ordinary belts:

20 to 50% Longer Life

Patented grommet V belts by B. F. Goodrich represent the only basic improvement since invention of the V

belt. Belts last 20 to 50% longer, depending on service. (The more severe the service the greater the increase over ordinary belts.)

What is a Grommet?

A grommet is like a giant cable except that it's endless—a cord loop built up by winding heavy cord on itself. There is no overlapping cord *section* as in all ordinary belts. Most belt failures occur in these sections where cords overlap!

All Cords Put to Work

Each grommet and every part of a grommet carries its share of the load. In ordinary belts under high tension the center cords "dish" because tension is greater near the driving faces. Dished cords are doing less work, not pulling their share. There are no cords in the center of grommet V belts, there is no dishing—therefore much more strength in proportion to cord volume.

Better Grip, Less Slip

Grommet V belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor. Because there is less slip there is also less surface wear.

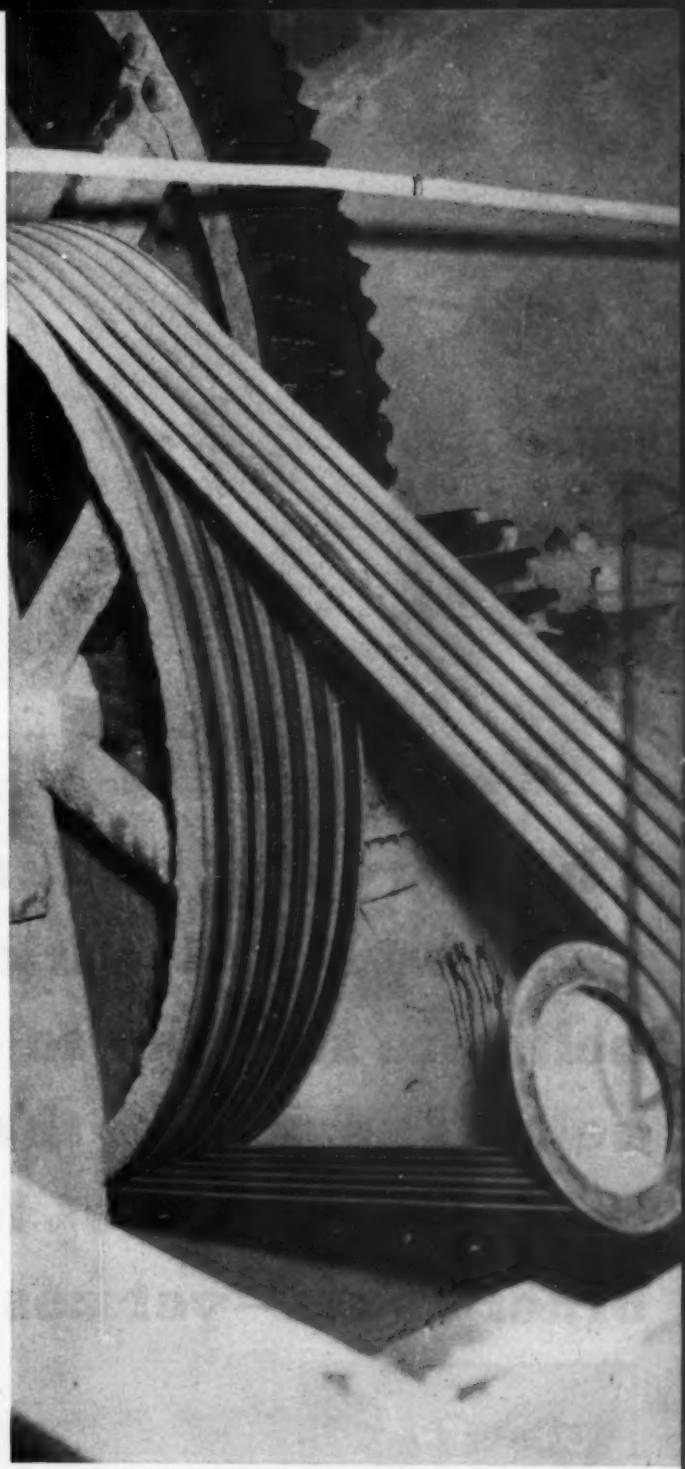
They Cost No More

You save belt costs because belts last longer, save production costs because machines keep running with fewer interruptions, save maintenance costs because they need less attention, yet cost not one cent more than others. Grommet belts are made in C, D and E sections. They are patented by B. F. Goodrich. No other V belt is a grommet belt (U. S. Patent Number 2,233,294).

20 ton ball team»

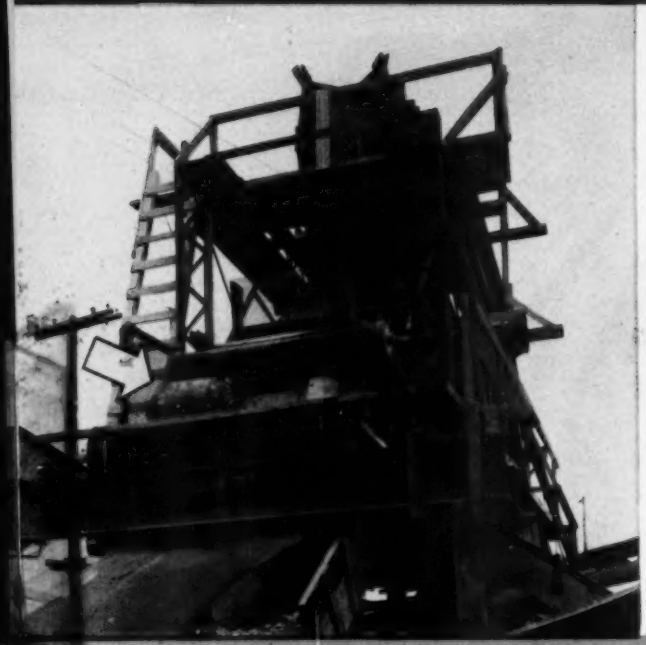
These rubber belts turn a ball mill containing 20 tons of steel balls, water and ore that grind until the mineral can be separated. Six ordinary belts weren't enough. They were falling to pieces from overwork in only 5 or 6 weeks.

The job was too big for six ordinary belts and there wasn't space to expand. Then B. F. Goodrich grommet belts were tried. The first grommet belts lasted not six weeks but six months, saved $100 a month in belt costs, saved a probable $800 for redesigning and rebuilding the drive.



Belts turn 20 tons of steel balls, water and ore to grind powder for paints.

B.F.Goodrich GROMMET BELTS AT WORK



Shakedown racket

Those three rubber belts run a screen at the M. A. Gammino Construction Co., Providence, R. I., that sorts rocks into different sizes. The screen shakes down 1000 tons of rock in a day. Ordinary V belts failed in one month because the drive whips and vibrates with such terrific force that the belts come apart.

B. F. Goodrich grommet V belts were installed six months ago, show no signs of giving any trouble.

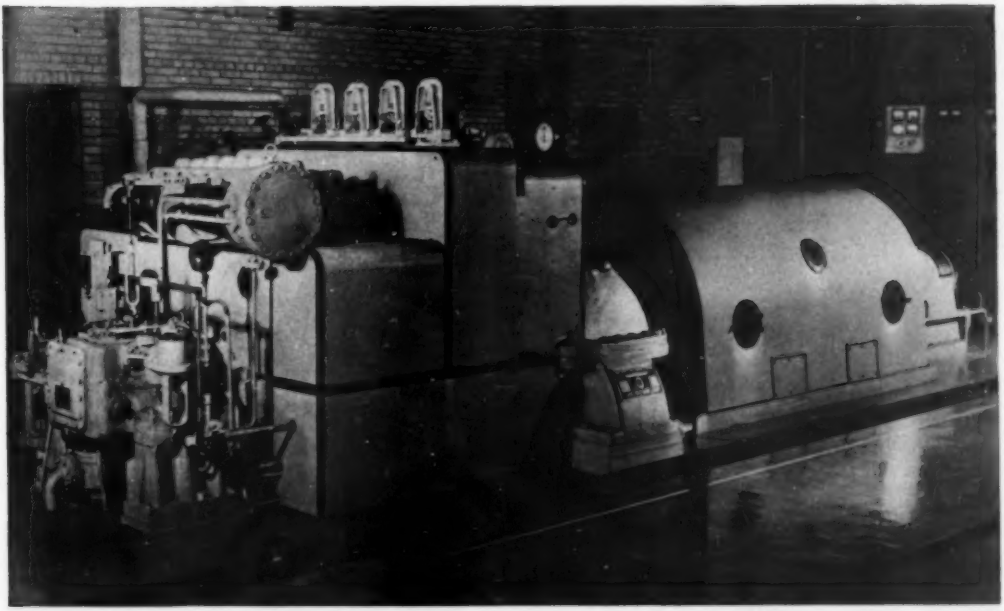
The grommet V belt is a typical B. F. Goodrich improvement—an improvement that saves money, does jobs better for industries of all kinds. Good reasons why it will pay you to get in touch with your BFG distributor when you need V belts.

Rocks have to pass screen tests, too.

These typical examples tell you why B. F. Goodrich grommet belts are superior to ordinary V belts. They prove that grommet belts last 20 to 50% longer than other types—yet cost no more.

Grommet V Belts BY
B.F.Goodrich
FIRST IN RUBBER

The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio



Story of an Economy Drive

How the Worthington Steam Turbine Pays Dividends for the City of Litchfield

What happened at Litchfield, Minnesota, is a clue to a most economical power plant operation.

Originally, the Litchfield municipal power plant consisted of low-pressure boilers, a steam engine and a small turbine-generator unit. The exhaust steam is sold for municipal heating.

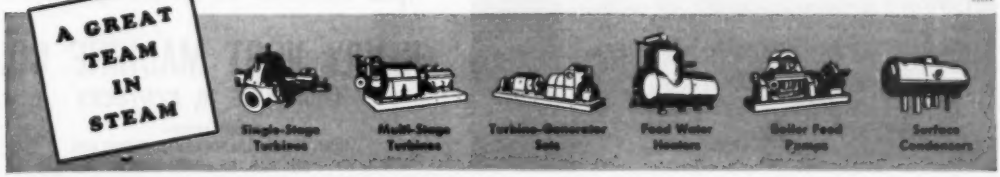
Next—a Diesel engine-driven generator was installed. The load grew, and finally, after a careful survey, it was decided to install a 3000-kw Worthington turbine generator and automatically extract steam for heating purposes.

Worthington builds steam turbines in all types and sizes—and turbine-generator sets up to 10,000-kw. For proof *there's more worth in Worthington*, call our nearest office or write to Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.

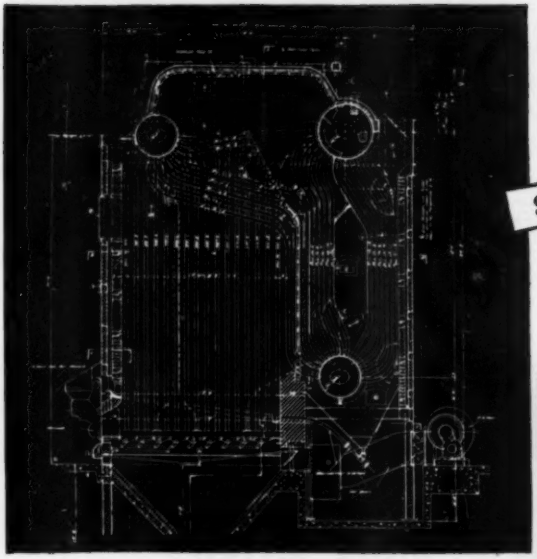
WORTHINGTON

STEAM TURBINE GENERATORS

T.1.9



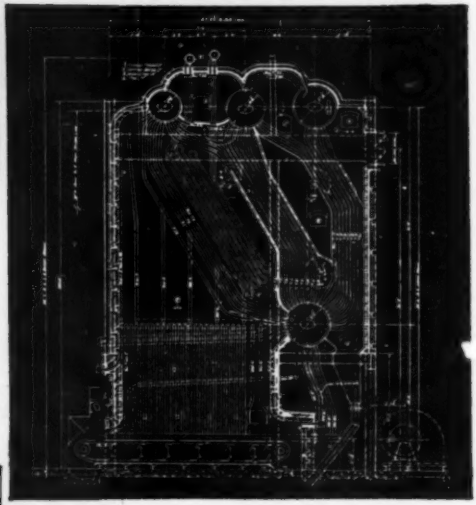
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY Vogt

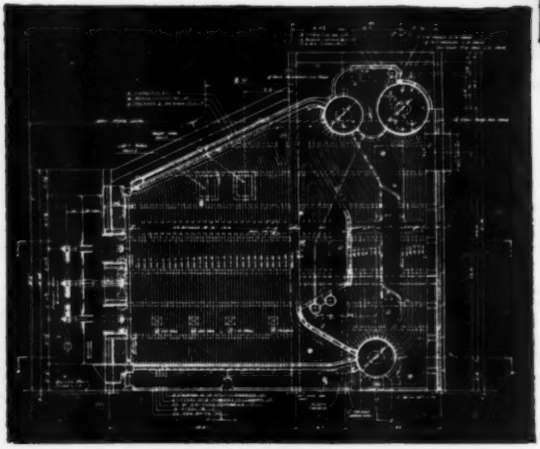
STEAM GENERATING UNITS



CLASS VL Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE Mt. Carmel Public Utility, Mr. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.

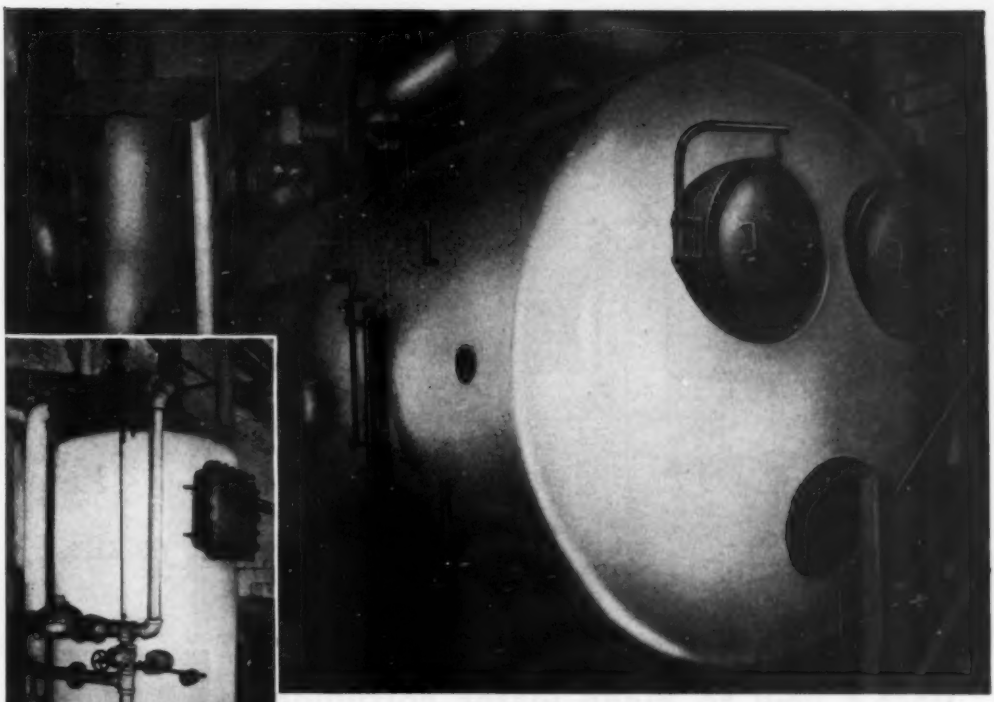


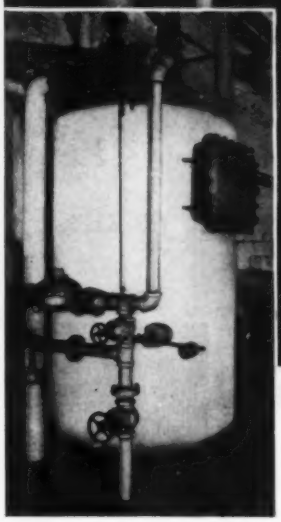
Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

BRANCH OFFICES:
NEW YORK, PHILADELPHIA, CLEVELAND
CHICAGO, ST. LOUIS, DALLAS





A Big Help

on small—as well as big—deaeration jobs

Small deaerators are big business at Worthington! That's why the plant with small-capacity requirements will benefit by getting acquainted with the complete range of Worthington deaerating equipment.

Worthington Gives You All Types, All Sizes

Worthington deaerating heaters and deaerators are built in sizes to handle from a few thousand pounds an hour to over a million. They are tailor-made to fit the particular requirements of each job. Special designs are available for operation with scale-forming water.

Both tray and steam-jet types are made—with external surface-type vent condensers or internal direct-contact vent condensing. They can be furnished for any practical operating pressure—constant or variable—or for vacuum operation.

With a complete range of sizes and types at their fingertips, Worthington engineers can competently recommend the design best suited to *your* requirements.

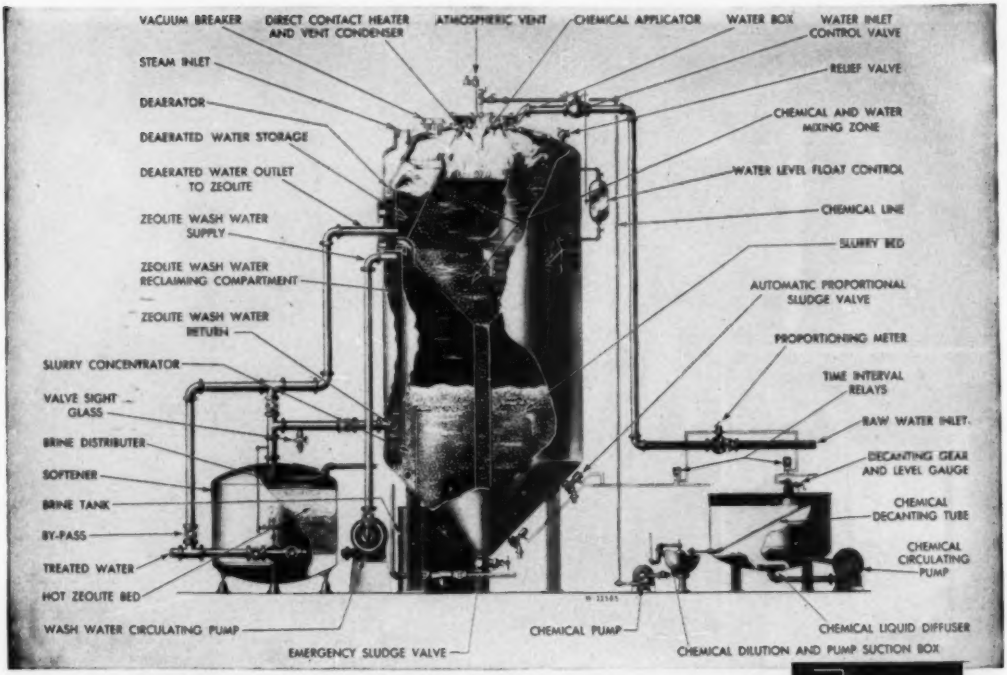
Remember, too, Worthington designs are backed by over 50 years experience in the design and manufacture of direct contact feedwater heaters and over 100 years experience in hydraulic machinery.

Send your water treating problem to Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, N. J.

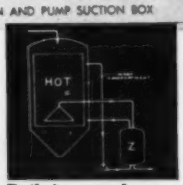
WORTHINGTON

DEAERATORS

E1.5



Here's how to make water softening a soft job for you



You have less to do . . . to worry about . . . to pay for—when you use Worthington's revolutionary Hot-Z Slurry-Type Deaerating Water Softener.

It combines all the best features of Hot Process and Zeolite, plus these Worthington-originated features:

No more scaling trouble. Direct-contact vent condenser eliminates scaling trouble experienced with old-fashioned shell-and-tube types.

Supervision reduced. Concentrated sludge is removed automatically and proportionately to water volume.

Assures uniformity. Hydraulic chemical mixer assures uniformity of chemical strength. Also saves space.

Easier cleaning of valve-type wash water sight glass.

Better deaeration. Steam-jet deaeration is simpler, gives better efficiency—removes oxygen to .005 cc per litre.

Independent backwash system. Built-in annular wash water compartment provides clear hot water for backwashing and reclaims it without affecting operating velocities in treating zone. This feature not only pays off in systems employing filters, but also is ideal for backwashing the hot zeolite.

You also save because Worthington Hot-Z Systems operate on low-priced lime and salt. The average installation saves enough in chemical costs to pay for itself in 3 years!

Get all the facts!

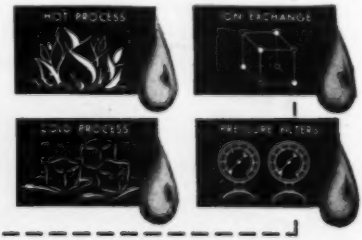
It will pay you to investigate the Worthington Hot-Z System thoroughly. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find *there's more worth in Worthington.* Worthington Pump and Machinery Corporation, Water Treating Section, Dunnellen, N. J.

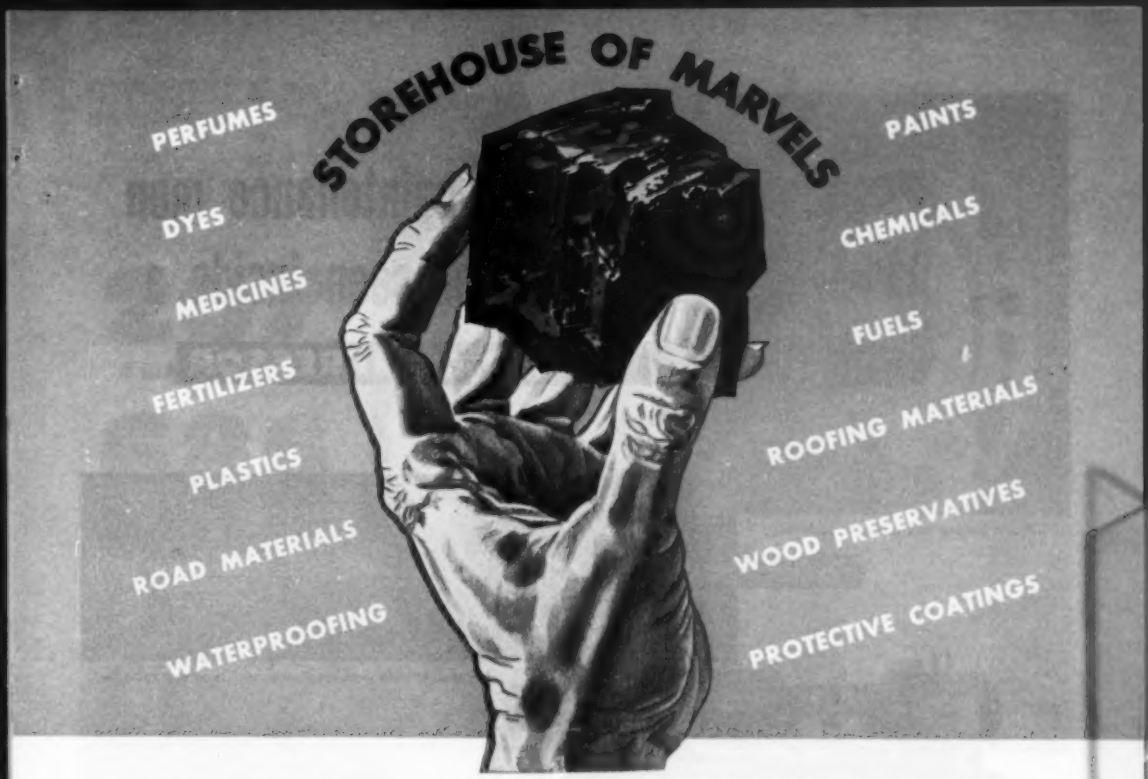
J3.2

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems





. . . but the greatest marvel of all is its *HEAT!*

It's amazing to think of such things as perfumes, fertilizers, dyes and medicines, coming from a lump of coal.

But it's even more amazing to consider the things that come from a lump of coal when it's put into a firebox . . . and burned! From this one source . . .

. . . Sixteen million homes in the nation get floods of responsive, dependable heat that fortifies them against the hardest winters,

. . . steam is generated that produces over half the electric power distributed by utilities (the same high percentage holds in the newest plants),

. . . heat and power for tens of thousands of commercial, institutional and industrial establishments in the populous eastern area is produced,

. . . twenty-five thousand steam locomotives still on the rails huff and puff and move the nation's freight.

Then, of course, there is the major contribution that coal makes to the manufactured gas industry—a vital utility in many sections.

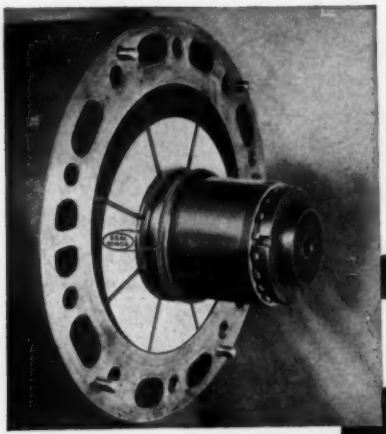
Coal can be stockpiled more readily than any other fuel. It is less likely to be affected by diversion—created shortages in periods of emergency. Virtually limitless resources eliminate any long-range fear of depletion. Beacon Coal offers added advantages. The fifteen Beacon coals are mined from fields famous for quality. Each offers desirable special properties that plus its performance. We'll be glad to talk to you about supplying your requirements.

EASTERN GAS AND FUEL ASSOCIATES
BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES

BOSTON CHICAGO CLEVELAND DETROIT NEW YORK
NORFOLK PHILADELPHIA SYRACUSE

For More Beacon Coal Information Write New England Coal & Coke Co., 120 Boylston Street, Boston 16, Mass.

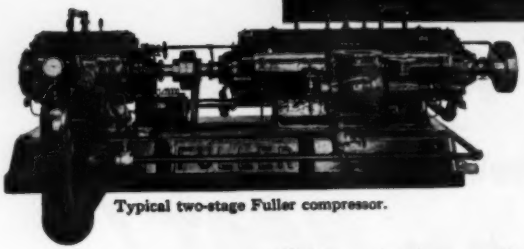


Rotor blades and cylinder assembly.

a lot of maintenance men have never seen inside a

FULLER COMPRESSOR

Accurately balanced, steel rotor with bearings mounted.



Typical two-stage Fuller compressor.

Rotor . . . bearings . . . blades—the only moving parts in a Fuller Rotary Compressor. There you have the three reasons why these compressors keep out of the repair shop. Fuller's efficient "heart" is your guarantee of economical and dependable service.

These are some of the important advantages of the Fuller Rotary—the reasons why thousands of these compressors are quietly and efficiently working for industry today: steady flow—no air-line pulsations, no valves to leak, direct drive from electric motor or internal combustion engine, simple foundation and small floor space, **maintained** capacity and efficiency for the life of the machine.

Whether your requirements call for a single-stage, two-stage or duplex combination, Fuller has the compressor **(to 125 psi. and 3300 cfm)** that will do the job better—longer. Investigate the Fuller Rotary Compressor. Complete information is given in Bulletin C-5. It's yours for the asking.

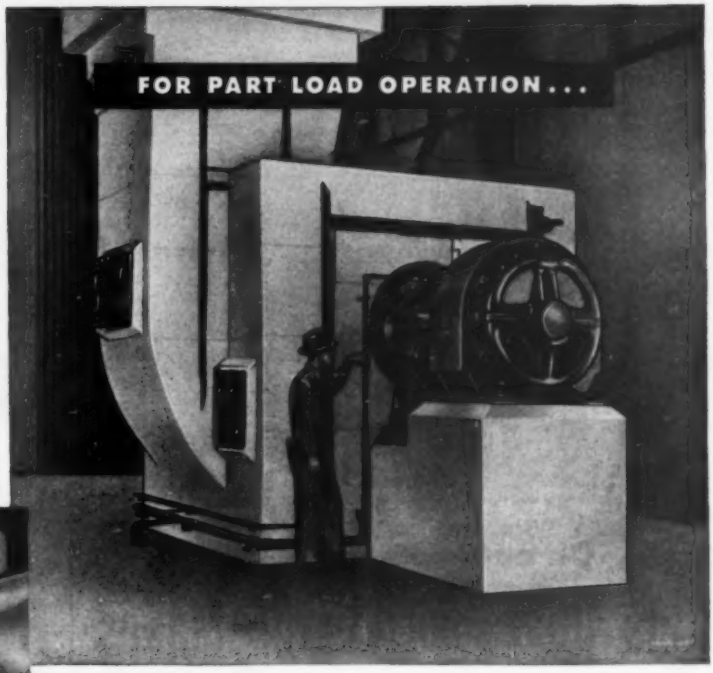
Fuller

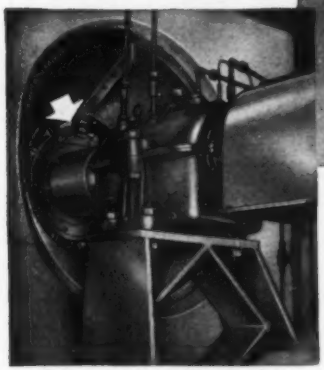
DRY MATERIAL CONVEYING SYSTEMS AND COOLERS • COMPRESSORS AND VACUUM PUMPS FEEDERS AND ASSOCIATED EQUIPMENT

FULLER COMPANY
Catasauqua, Pennsylvania
Chicago 3—120 So. LaSalle St.
San Francisco 4—420 Chancery Bldg.

C-218

207 COMPANIES 686 FANS





Enlargement shows that operating mechanism of the new Sturtevant Vane Control is outside the gas stream. It is free from build-up of fly ash and is readily accessible for inspection.

Write today for DB 92-810 describing Vane Control.

207 COMPANIES ARE NOW USING NEW STURTEVANT VANE CONTROL® FOR 686 MECHANICAL DRAFT FANS

HERE'S WHY—Adjustable Inlet Vane Control is the most efficient and economical means of controlling fan output over a wide percentage of capacity. Regulation to exact pressure and volume requirements is instantaneous and permits great power savings when the system is not operating at full rated capacity. A few of these 207 companies are listed below:

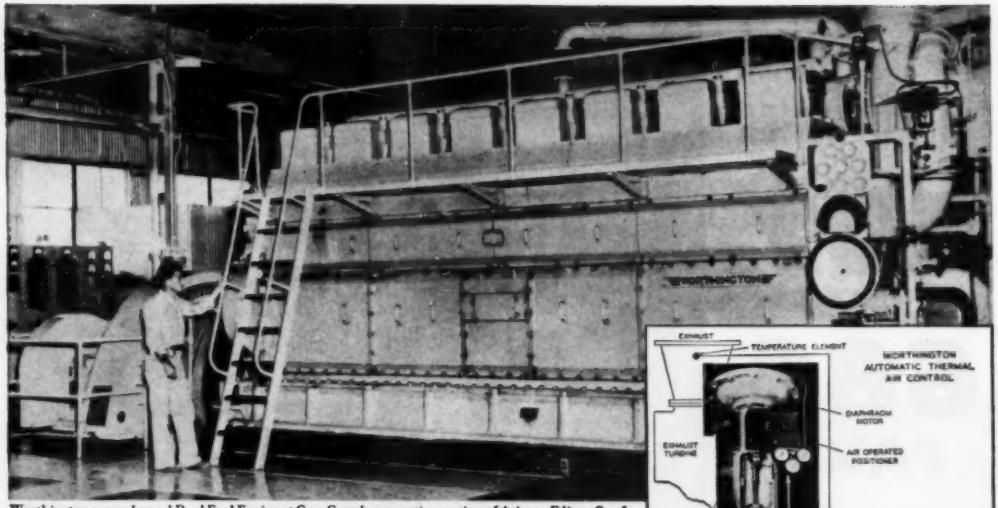
CENTRAL STATIONS	INDUSTRIAL PLANTS
Alabama Power Company	Aluminum Company of America
American Gas & Electric System	American Tobacco Company
Cleveland Electric Illuminating Co.	Caterpillar Tractor Company
Consolidated Edison Company	The Coca-Cola Company
Metropolitan Edison Company	Diamond Alkali Company
New Jersey Power & Light Company	Esso Standard Oil Company
New York State Electric & Gas Corp.	Lever Brothers Company
Pacific Gas & Electric Company	Pratt & Whitney Aircraft
Pennsylvania Electric Company	Revere Copper & Brass Incorporated
Philadelphia Electric Company	United States Rubber Company

Full information on power savings through the use of Vane Control with forced or induced draft fans, industrial fans and centrifugal compressors is given in DB 92-810. For a free copy, write Westinghouse Electric Corp., Sturtevant Division, 163 Damon Street, Hyde Park, Boston 36, Massachusetts.

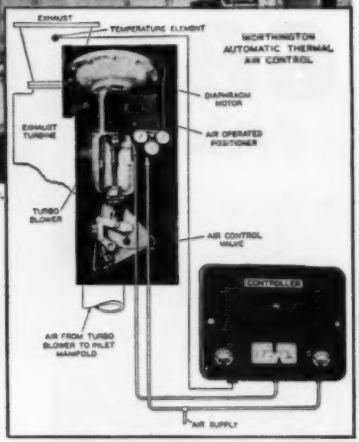
YOU CAN BE SURE...IF IT'S **Westinghouse**

PUTTING *Air* TO WORK

J-80236



Worthington supercharged Dual Fuel Engine at Casa Grande generation station of Arizona Edison Co., Inc.



On natural gas or oil...

This Dual Fuel Engine Makes Low-Cost Power at Casa Grande

Casa Grande, near Phoenix, is one of the more important power stations in the Arizona Edison Company system.

Although natural gas is plentiful and nearby, the station is equipped with a Worthington Dual Fuel Engine, which can change over to oil instantaneously.

That's so the type of fuel used can be determined day to day, depending on costs and availability. There are no switchover shutdowns.

This installation is just *another* illustration of the fact that Worthington has the right engine for *any* local condition—proof that Worthington can always help you increase efficiency and lower power production costs. For further information, write Worthington Pump and Machinery Corporation, Engine Division, Buffalo, N. Y.

THIS CONTROL CUTS FUEL CONSUMPTION FOR BEST ENGINE PERFORMANCE

The Worthington Automatic Thermal Air Control maintains optimum air-fuel ratio at all times. Result: better engine performance with lower fuel consumption at all engine loads.

This control is used exclusively by Worthington on super-charged dual-fuel engines. It is actuated by the exhaust temperature. Provides automatic variation of air quantity in direct relation to ambient air temperatures. Automatically compensates for changes in heating values of gas fuel. No other type of automatic controller offers these features.

Other exclusive features include dual plunger fuel oil injection pumps and micro-metering gas valves on each cylinder. They are further assurance of better, more economical operation of Worthington Dual Fuel Engines under all load conditions and with varying qualities of gas and fuel oils.

WORTHINGTON

ENGINES E.1.6

ECONOMICAL CONTINUOUS POWER

Diesel Engines, 150 to 2640 hp
Gas Engines, 190 to 2880 hp
Dual Fuel Engines, 345 to 2640 hp

WORTHINGTON-BUILT AUXILIARIES

Engine Starting Compressors

Oil Transfer Pumps

Cooling Water Circulating Pumps

Evaporative Type Engine Water Coolers

STOP RUST

You can stop rust with RUST-OLEUM! An exclusive formula proved in a wide range of industrial and marine applications for more than 25 years. Its tough, pliable film dries to a firm rust-resisting coating that protects against rust—cuts maintenance costs—adds years of use to many metal surfaces, indoors and outdoors.

RUST-OLEUM may be applied over rusted surfaces without removing all the rust, assuring substantial savings in preparation time... It is only necessary to remove all the rust scale and loose rust.

Prompt delivery from Industrial Distributor stocks in principal cities. See *Sweets* for complete catalog and nearest source of supply, or write for complete literature on your company letter head today!

Beautifies AS IT PROTECTS

FREE SURVEY: Place your rust problems in the hands of a RUST-OLEUM specialist. He will survey your plant for all rust problems, submit detailed recommendations, and make specific tests.

Available in many **COLORS,** aluminum and white

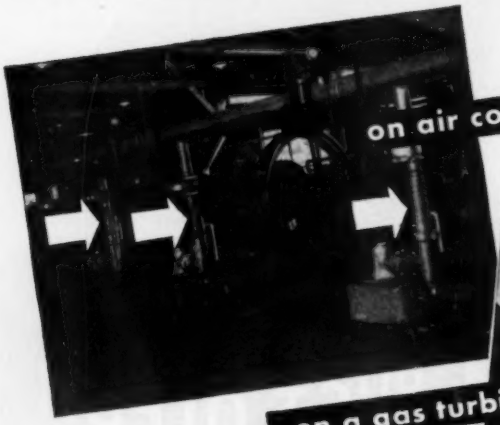
"Rigid Economy, Men"

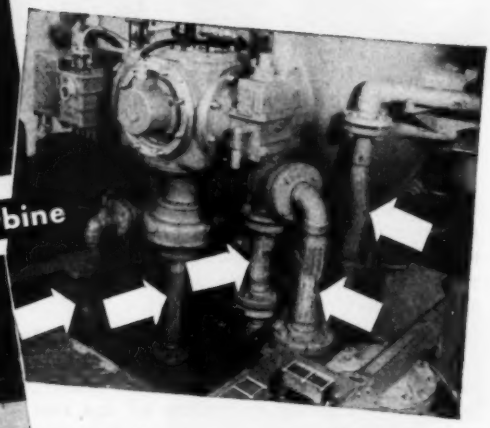
RUST-OLEUM CORPORATION

2471 Oakton Street, Evanston, Illinois

Let CMH FLEXIBLE METAL HOSE

take the motion . . .





and your equipment *will last longer!*

In all types of connections subject to vibration, misalignment, flexation or expansion and contraction, CMH Flexible Metal Hose will solve the problem economically and dependably . . . and in most cases, it will simplify piping hook-ups and make them easier to assemble and dissemble. Your equipment will last longer, too, if CMH Flexible Metal Hose is used to absorb the damaging effects of motion in rigid assemblies or to relieve the stresses of misalignment.

There is a CMH hose type or standard assembly to meet virtually every need. CMH distributors, located in principal cities, will be pleased to give you full information . . . see your classified telephone directory or write for literature.

REX-WELD corrugated steel and bronze hose is available in standard sizes from 3/16" through 12" I.D. for burst pressures to 12,000 psi, temperatures to 1000° F. Stainless steel types also available.

REX-TUBE convoluted hose is available in a variety of types including square locked, ball bearing and fully interlocked in a variety of metals including steel, bronze and other alloys.

Flexon identifies CMH products that have served industry for over 49 years.

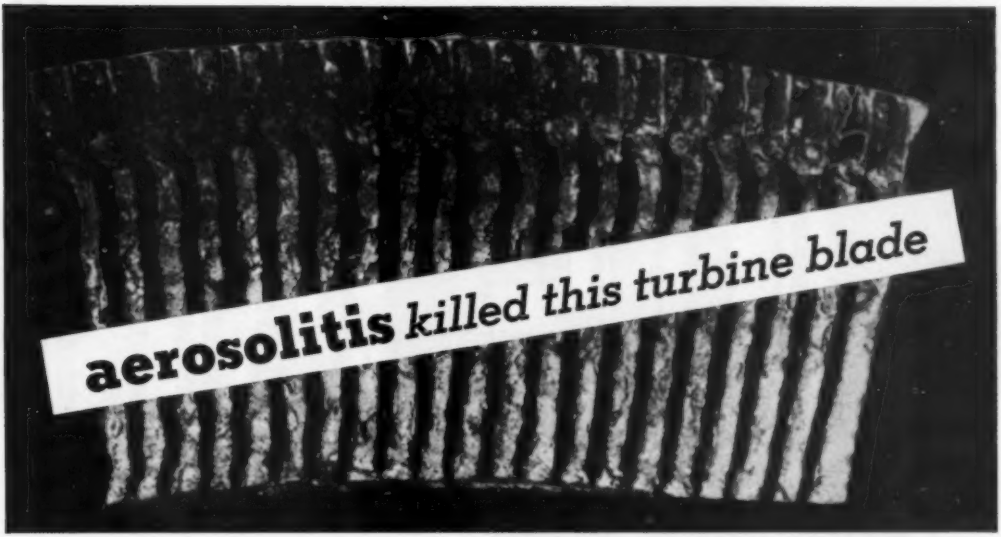
CHICAGO METAL HOSE Corporation

1335 S. Third Ave. • Maywood, Ill. • Plants at Maywood, Elgin, Rock Falls, and Savanna, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

CMH

ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems • Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components



Dearborn polyamide anti-foams prevent this

deadly boiler disease

Here is an unretouched photo of a turbine blade that was *killed by aerosolitis.* Replacement was, of course, both necessary and expensive.

But *aerosolitis*—more prevalent with some waters than with others—can be easily and inexpensively prevented with Dearborn Improved Polyamide Anti-Foams. In addition to inhibiting the formation of harmful *aerosols,* Dearborn Polyamide Anti-Foams prevent foaming to produce purer steam—eliminate scale formations—condition sludge—are compatible with other treatment.

IF YOU USE STEAM for power or process, investigate the time-, money-, and labor-saving advantages of Dearborn Polyamide Anti-Foams and the complete Dearborn Industrial Water Treatment and Engineering Service. A Dearborn engineer is at your service. The coupon is for your convenience.

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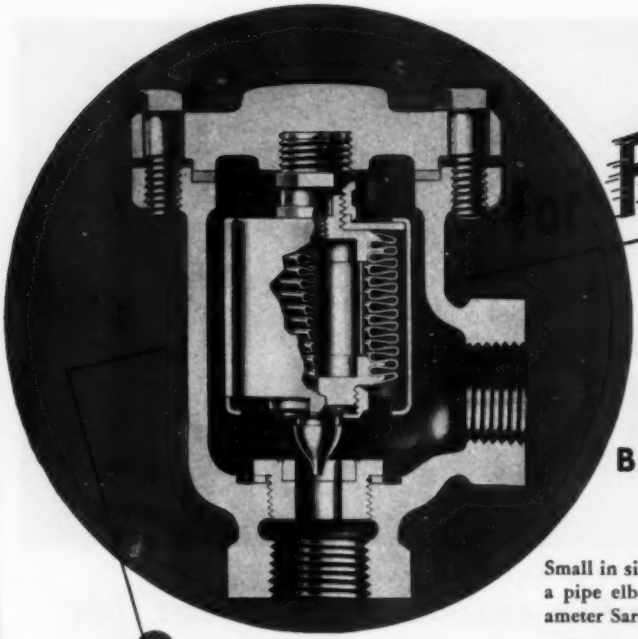

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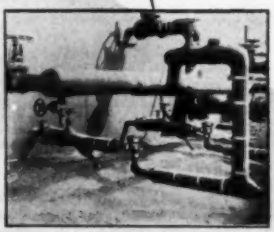

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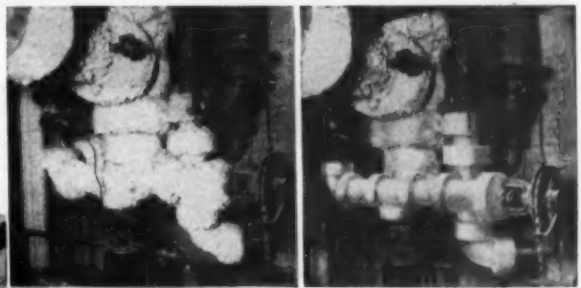

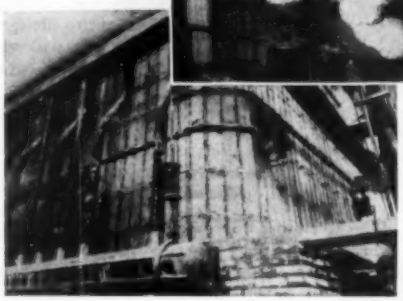

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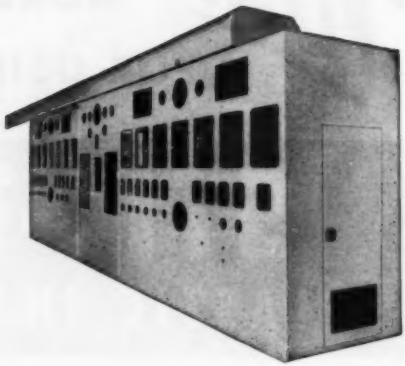

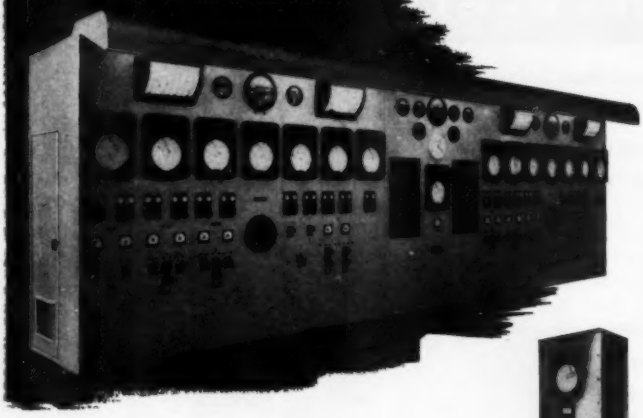

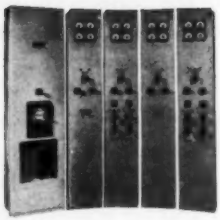

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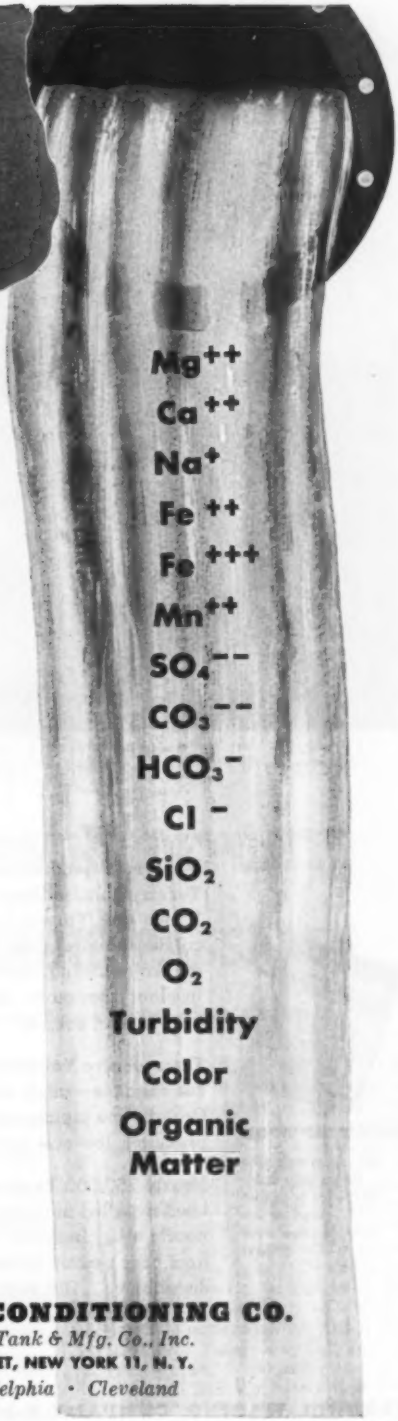

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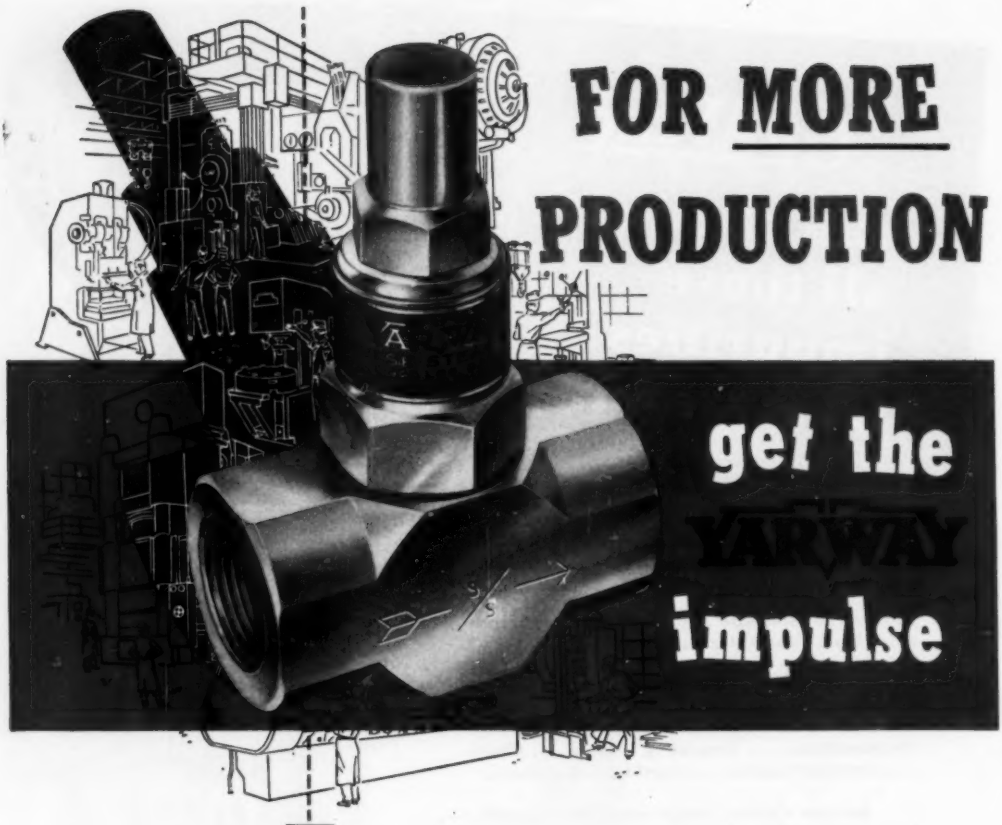

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INDUSTRIAL POWER

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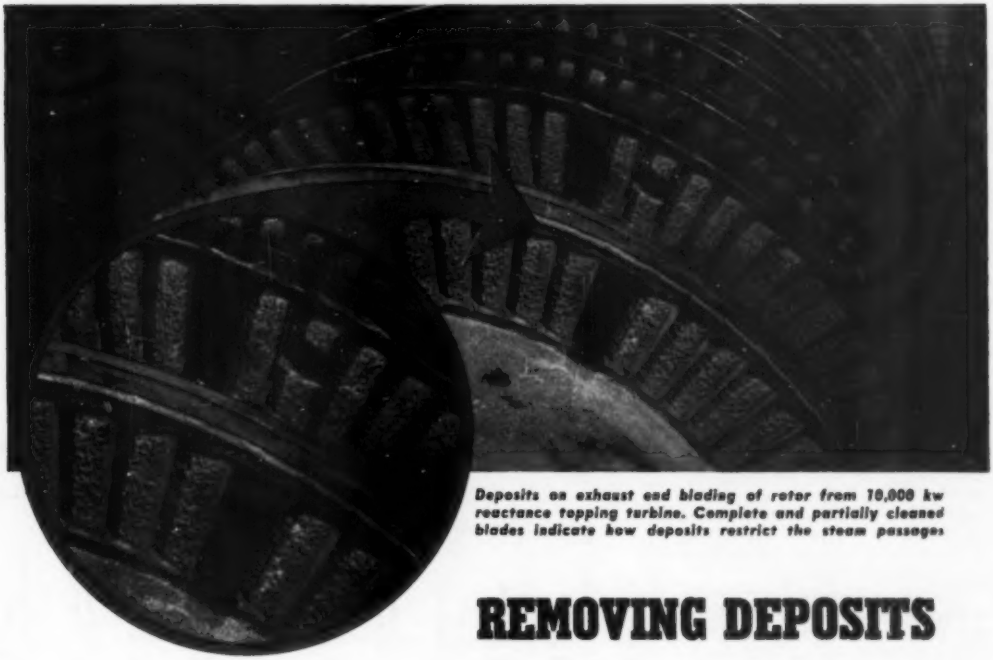


Deposits on exhaust end blading of rotor from 10,000 kw reactance topping turbine. Complete and partially cleaned blades indicate how deposits restrict the steam passages

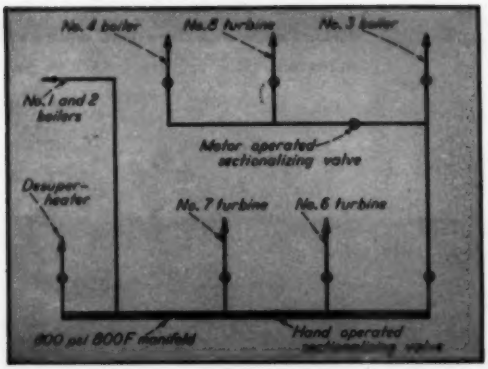
REMOVING DEPOSITS FROM STEAM TURBINE PASSAGES

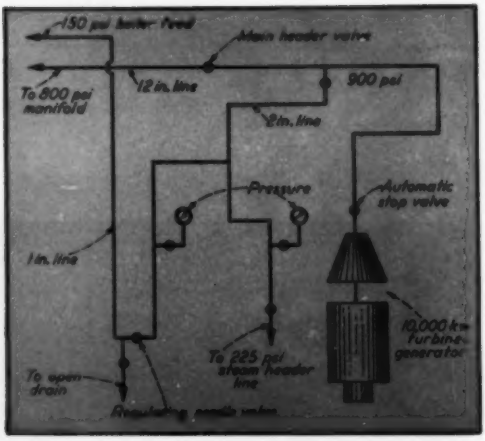
W. K. DUMBAUGH, *Superintendent of Power Plants, Weirton Steel Company*

Here are complete case histories on three industrial power plant turbines dating back to 1936. Data show increased electrical capacity and efficiency of the turbine-generators after each washout. Improvement in washing technique resulted in over 200 per cent increase in operating hours between washouts. Adherence to accepted steam-generating principles and practices are recommended if deposits in turbine passages, formed by continued carryover from boilers, are to be minimized

CONTINUED CARRYOVER from steam boilers forms deposits in the steam passages of steam turbines, thereby reducing the efficiency and capacity of a great portion of these prime movers. Deposits consist of soluble and insoluble material, depending on the type of feed-water treatment and load conditions. When soluble, it can be removed by washing the turbine with initially wet steam.

In this article, written solely from a practical standpoint, no attempt is made to enter into chemistry of water treatment. Since lime-soda water treatment is used in the power plant at the Weirton Steel Co., deposits in steam turbine passages have all been water





Above: Weirton Steel's power plant has an 800 psi 800 F steam manifold supplied by four 400,000 lb per hr boilers. Right: Piping arrangement for washing No. 6 topping turbine

soluble and made up primarily of sodium hydroxide and sodium chloride with a smaller percentage of sodium sulphate and sodium silicate.

Three high pressure turbines are in operation. There are two topping turbines operating on 800 psi 800 F total temperature steam, discharging into a low pressure steam header line at 225 psi with 540 F total temperature; they drive 3600 rpm a.c. generators rated 10,000 kw at 80 per cent power factor. The third turbine operates on 800 psi 800 F total temperature steam exhausting to a vacuum and driving a 25,000 kw, 80 per cent power factor a.c. generator at 3600 rpm.

The first unit installed was the No. 6 topping turbine in June, 1936. At that time, turbine washing was practically unheard of with no recommendations by the manufacturers. Over a period of operation following the installation of this unit, it was noted that electrical output gradually decreased. From changes in pressures observed throughout the unit, it was evident that deposits were forming on the buckets, thereby decreasing available capacity and efficiency of the turbine.

Being faced with several days outage so the machine could be dismantled for cleaning, various methods of washing were considered and tried out over a period of time. The first washout was made on February 28, 1937. During the ensuing years, experiments were continued until the present method was attained for the first time on May 30, 1943 during a washout of the No. 6 topping turbine. Previous to this washout, operating time between washing periods ranged from 1400 to 1700 hr while at present this same unit operates from 4400 to 4600 hr between washouts. Capacities before and after washing No. 6 topping turbine,

TABLE 1 — WASHOUT INFORMATION ON No. 6 TOPPING TURBINE

Date of washout	Operating hours	Power generated, kwh	Avg. kw per hr	Full load capacity, kw Before washing	Full load capacity, kw After washing
6-26-40	1,397	14,889,000	10,651	10,000	12,700
6-14-42	1,743	17,464,000	10,019	9,300	13,400
12- 4-43	4,494	45,626,000	10,153	9,500	13,000
1- 1-45	4,353	47,842,000	10,990	10,700	13,900
1-14-47	4,608	53,075,000	11,518	10,800	14,000
8-21-49	4,247	46,660,000	10,935	10,800	13,900

All the above full load capacity readings taken at 215 psi exhaust pressure with slight variations in the inlet pressure and temperature.

TABLE 2 — COMPILED AVAILABILITY INFORMATION ON No. 6 TOPPING TURBINE

Year	Installed hours	Operating hours	Washouts	Washout hours	Washout, % availability	Repair hours	Repair, % availability	Total, % availability	No. hours unavailable*	Kwh generated K x 1000
1936	4752	4683	—	—	100.	69	98.55	98.55	—	42,858
1937	8760	8607	6	49	99.44	104	98.82	98.26	—	79,790
1938	8760	8277	6	59	99.33	424	95.16	94.49	—	76,819
1939	8760	8651	6	56	99.36	53	99.40	98.76	—	90,871
1940	8784	8673	6	55	99.37	56	99.37	98.74	—	92,857
1941	8760	8588	7	73	99.17	99	98.87	98.04	—	74,510
1942	8760	8621	6	68	99.22	71	99.19	98.42	—	85,836
1943	8760	8653	3	32	99.60	40	99.54	98.70	35	89,694
1944	8784	7939	1	7	99.92	820	90.64	90.53	18	87,674
1945	8760	8650	4	49	99.44	58	99.34	98.70	3	95,322
1946	8760	8707	2	24	99.73	22	99.80	99.30	7	98,068
1947	8760	8576	3	37	99.58	147	98.32	97.41	—	98,077
1948	8784	8025	2	23	99.73	700	92.03	91.77	36	90,907
1949	8760	8714	2	26	99.70	20	99.77	99.47	—	97,443
1950**	6553	6520	2	24	99.63	5	99.92	99.56	4	72,521
Total	125257	121884	56	582	99.54	2688	97.85	97.39	103	1,273,247

*Designates time the unit was out of service due to no fault of its own.
**Includes all figures through September 30, 1950.

TABLE 3 — WASHOUT INFORMATION ON No. 7 TOPPING TURBINE

Date of washout	Operating hours	Power generated, kwh	Avg. kw per hr	Full load capacity, kw Before washing	Full load capacity, kw After washing
7-10-45	10,493	91,539,000	8,723	12,000	12,600
7-28-46	9,080	75,197,000	8,281	11,200	12,500
1-12-48	9,154	91,172,000	9,959	11,900	13,500
3- 6-49	7,991	78,135,000	9,978	11,000	13,500
7- 4-50	11,625	112,646,000	9,690	10,800	12,700

All of the above full load capacity readings taken at 225 psi exhaust pressure with slight variations in the inlet pressure and temperature.

TABLE 4 — COMPILED AVAILABILITY INFORMATION ON No. 7 TOPPING TURBINE

Year	Installed hours	Operating hours	Washouts	Washout hours	Washout, % availability	Repair hours	Repair, % availability	Total, % availability	No. hours unavailable*	Kwh generated x 1000
1940	96	80	—	—	—	16	83.00	83.00	—	324
1941	8760	8531	—	—	—	229	97.38	97.38	—	80,581
1942	8760	8627	—	—	—	133	98.48	98.48	—	63,183
1943	8760	8728	—	—	—	32	99.63	99.63	—	69,115
1944	8784	7981	—	—	—	803	90.86	90.86	—	69,460
1945	8760	8662	1	16	99.82	60	99.31	98.80	22	75,505
1946	8760	8621	2	34	99.61	48	99.54	98.40	65	73,251
1947	8760	8744	—	—	—	3	99.90	99.99	13	84,149
1948	8784	8099	1	16	99.82	667	92.41	92.22	2	88,395
1949	8760	8722	1	21	99.76	15	99.83	99.59	2	85,746
1950**	6553	6505	1	15	99.77	10	99.85	99.62	23	62,495
Total	85537	83300	6	102	99.88	2008	97.55	97.43	127	744,224

*Designates time the unit was out of service through no fault of its own. **Through September, 1950.

TABLE 5—No. 6 TURBINE CONDITIONS DUE TO DEPOSITS AND WASHOUT

Date	H-P steam, psi	H-P steam temp., F	L-P steam, psi	L-P steam, temp., F	1st stage	5th stage	9th stage	Differential	Peak kw x 1000
1944									
7/6	820	820	215	530	705	435	269	54	13.3
7/7	820	780	215	545	706	440	270	55	13.0
7/17	820	810	215	545	707	445	272	57	12.4
7/28	820	825	215	560	708	449	273	58	12.2
8/8	820	825	215	560	708	454	274	59	12.2
8/18	820	810	215	550	709	460	275	60	12.1
8/28	820	815	215	550	709	465	277	62	12.0
9/2	820	820	215	550	710	467	278	63	11.9
9/9	820	790	215	520	710	469	279	64	11.8
9/21	820	840	215	580	711	471	281	66	11.7
9/28	820	815	215	560	712	473	282	67	11.6
10/3	820	820	215	560	712	475	283	68	11.5
10/9	820	815	215	560	712	477	284	69	11.4
10/20	820	785	215	525	712	478	286	71	11.1
10/24	820	825	215	560	712	479	287	72	11.0
11/7	820	845	215	580	713	482	290	75	11.0
11/15	820	810	215	550	713	484	292	77	11.0
11/20	820	815	215	560	713	488	293	78	11.0
11/29	820	805	215	545	713	490	295	80	11.0
12/4	820	830	215	580	714	492	296	81	11.0
12/15	820	825	215	575	714	496	297	82	10.9
12/21	820	820	215	550	714	498	298	83	10.8
12/28	820	825	215	580	714	499	299	84	10.8
1945									
1/1	820	840	215	580	715	500	302	87	10.7
		(Off line - 2:38 p.m., 1/1/45 — On line 4:05 a.m., 1/2/45) Washout							
1/2	820	830	215	555	710	443	268	53	13.9

NOTES: (1) Total operating time between washout periods — 4353 hr. (2) Total power generated between washout periods — 47,842,000 kwh. (3) Hourly average between washouts.— 10,990 kw.

TABLE 6—No. 7 TURBINE CONDITIONS DUE TO DEPOSITS AND WASHOUT

Date	H-P steam, psi	H-P throttle, psi	H-P steam temp., F	L-P steam, psi	L-P steam temp., F	Balance piston	Impulse	First reactance	Second reactance	Differential gage	Peak kw x 1000	Differential
1946												
12/28	820	820	790	225	545	228	810	775	550	257	12.0	32
1947												
1/18	820	820	825	225	565	228	810	780	552	258	12.6	33
2/26	820	820	830	225	570	228	808	782	555	260	12.2	35
4/3	820	820	820	225	570	228	810	785	556	260	12.0	35
7/25	820	820	840	225	590	228	810	785	556	260	12.0	35
8/18	820	820	850	225	600	228	808	780	556	260	12.0	35
9/9	820	820	850	225	595	228	810	780	558	261	12.2	36
9/24	820	820	830	225	600	228	810	780	559	262	12.1	37
10/20	820	820	825	225	580	228	809	785	560	265	12.0	40
10/28	820	820	830	225	580	228	810	785	562	267	12.0	42
11/19	820	820	820	225	580	228	807	785	570	268	12.0	43
1948												
1/5	830	820	810	225	575	228	806	785	576	270	11.5	45
1/10	835	825	830	225	595	228	810	785	580	272	11.9	48
		(Off line - 7:09 a.m., 1/11/48 — On line - 8:51 a.m., 1/12/48) Washout										
1/12	815	810	825	225	570	228	805	780	465	260	13.5	35

NOTES: (1) Total operating time between washout periods — 9154 hr. (2) Total power generated between washout periods — 91,172,000 kwh. (3) Hourly average between washouts — 9959 kw.

as well as data for interim periods, are given in Table 1. Table 2 lists additional data on No. 6 turbine, including availabilities, and is self-explanatory.

The No. 7 topping turbine does not require as frequent washing due to a designed second reaction stage bypass valve, which makes possible the admission of high pressure, high temperature steam to the exhaust end of the turbine. This valve is operated on each 8 hr turn under heavy load conditions. It is believed that this tends to crack the deposits and clean the exhaust end blading, the deposits in topping turbines being at this point. Information and data on washouts, operation between washouts, and availability are given in Tables 3 and 4.

The third high pressure unit known as No. 8 is a condensing turbine. Only in respect to location do deposits in this unit differ from deposits in the two topping turbines. The deposits form on the buckets or blading of the topping turbines in the exhaust stages, whereas the formation is in the front or high pressure end of the condensing turbine.

Installation of gages at various points on all three turbines provide positive information as to the location of such deposits. Experience in translating this information tells plant engineers when each turbine must be washed out. Periodic readings are taken at given inlet and exhaust pressures. Relative pressures on all three turbines due to deposit formations and resultant washing are given with other pertinent operating information in Tables 5, 6 and 7.

While the No. 8 unit installation was rather recent, its availability record is given in Table 8.

The steam for operation of these turbines is supplied by four 400,000 lb per hr boilers and enters a double manifold located in the steel works powerhouse as shown in one of the drawings.

While the details of washing arrangements vary slightly, the principle of washing is identical on all three units; therefore, the following descriptive information pertaining to No. 6 turbine applies in all cases. The piping arrangement used is sketched in the second drawing.

Primary concern in washing turbines is the amount of contraction and expansion taking place during temperature changes; therefore, temperature changes are so made as to permit gradual movement of the machines. This requires temperature changes ranging from 50 to 100 F per hr, depending on the characteristics of each particular machine.

Washout Technique

The washout system utilizes low steam and water pressures. The steam is supplied through a 2 in. pipe running from the 225 psi steam header line, while the water is supplied through a 1 in. pipe from the boiler feedwater line at the boilerhouse. The 2 in. steam pipe and 1 in. water pipe are connected into a 2 in. high pressure tee which serves as a mixer. The mixer is located immediately ahead of the main header line expansion bend, between the main turbine inlet header valve and the turbine automatic stop valve. The steam is controlled by a globe valve, while the water is kept at a desired temperature by bleeding with a drain and regulated into the mixer by use of a 1 in. needle valve. The mixture enters the main expansion bend approximately 18 ft ahead of the automatic stop valve. The element for the temperature recorder is in the main steam header line immediately ahead of the turbine automatic stop valve. With throttling valves properly placed, the steam driving the unit can be regulated and changed from high pressure to low pressure steam, or from low pressure to high pressure, whichever is most desirable.

Following is an account of an actual washout of No. 6 turbine:

After the machine had been taken out of service and the steam shut off by means of the main inlet high pressure valve, the machine began to slow down. The motor-operated exhaust valve was closed as the 6 in. atmosphere valve was opened. The machine was permitted to drop to a speed of 300 rpm.

All control valves were completely opened and the speed regulated by a 1 in. by-pass valve on the main inlet high pressure valve. This steam had a temperature of 850 F. Upon the throttle temperature levelling out with all drains opened and with all temperature and pressures carefully observed, low pressure steam at 540 F was slowly admitted to the above-mentioned mixer. This steam, mixing with the high temperature steam, gradually started the decrease in temperature. As the volume of the 540 F steam was increased, the 850 F steam was decreased through the bypass valve until the 850 F steam was completely shut off with a minimum of 550 F. This drop was at an average of approximately 100 F an hr.

Boiler feedwater at 160 psi was admitted to the mixing chamber with steam at 70 psi. By regulation of the needle valve, water was gradually increased until saturation was reached and water freely flowed from the exhaust line sampling valve with an inlet

TABLE 7—No. 8 TURBINE CONDITIONS DUE TO DEPOSITS AND WASHOUT

Date	Throttle, psi	Throttle temp., F	Primary inlet	Impulse chamber	Gages 1	Gages 2	Gages 3	Gages 4	Exhaust vacuum	Exhaust temp., F	Tail water temp., F	Steam flow, lb x 1000	Peak kw x 1000	River temp., F
12-6-49	800	795	790	465	410	210	55	3.0	28.4	98	36	318	35.0	46
3-23-50	815	830	810	520	547	235	55	2.0	28.5	96	76	295	33.8	48
6-16-50	805	855	795	570	580	260	60	0.0	26.8	120	110	278	31.0	77
9-15-50	810	855	805	593	610	268	60	0.0	27.0	115	110	265	29.0	79
		(Off line - 8:14 a.m., 9-17-50 — On line - 5:55 a.m., 9-18-50) Washout												
9-19-50	800	845	790	470	480	224	69	3.0	26.6	119	108	320	34.5	74

NOTES: (1) Total operating time between washout periods — 6948 hr. (2) Total power generated between washout periods — 162,130,000 kwh. (3) Hourly average between washouts — 23,479 kw.

TABLE 8—DATA COMPILED ON No. 8 CONDENSING TURBINE

Year	Installed hours	Operating hours	Washouts	Washout hours	Washout, % availability	Repair hours	Repair % availability	Total % availability	Hours unavailable	Kwh x 1000 generated
1947	4491	4277	—	—	—	83	98.15	98.15	131	86,810
1948	8784	8719	1	21	99.76	3	99.97	99.73	41	199,960
1949	8760	8105	1	18	99.79	594	93.22	93.01	43	189,910
1950*	6553	6527	1	17	99.73	5	99.92	99.66	4	152,808
Total	28588	27628	3	56	99.80	685	97.60	97.41	219	629,488

*Includes all figures through September 30, 1950

TABLE 9—CONDUCTIVITY READINGS DURING No. 6 TURBINE WASHOUT

Sample No.	Notes	Time taken	Resistance, ohms	Conductivity, ohms	Speed, rpm
1	A	2:30 p.m.	2.25	0.444	785
2	B	2:35 p.m.	7.00	0.142	630
3	C	2:45 p.m.	10.00	0.099	630
4		3:00 p.m.	16.00	0.062	730
5		3:15 p.m.	21.00	0.047	720
6	D	3:30 p.m.	22.00	0.045	705
7		3.45 p.m.	14.00	0.071	730
8	E	4:00 p.m.	23.00	0.043	665
9		4:15 p.m.	16.00	0.062	750
10		4:30 p.m.	25.00	0.040	615
11		4:45 p.m.	25.00	0.040	610

NOTES: (A) Two turns of water. (B) Two and one-half turns of water. (C) Three turns of water. (D) Water off, temperature raised 45 F, and water back on. (E) Water off, temperature raised 80 F and water back on.

All samples tested on a.c. Wheatstone bridge at 150 F. Test discs spaced at 0.078 in. Saturation at 2:45 p.m. Washout completed at 4:45 p.m.

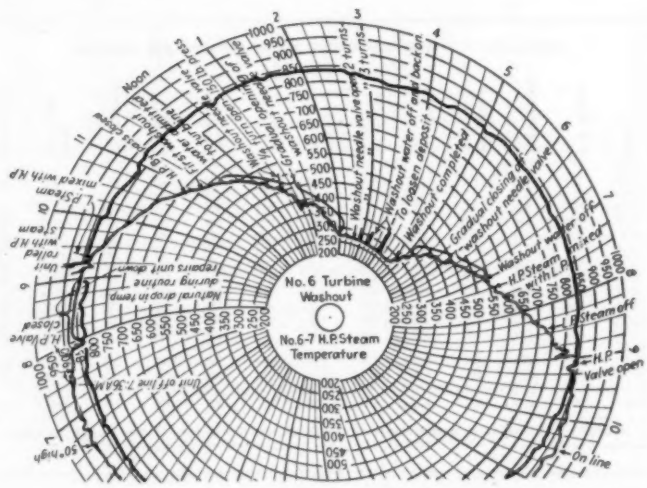
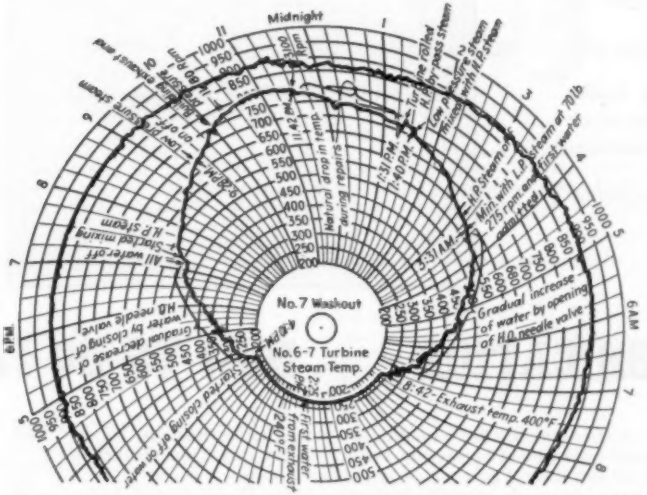


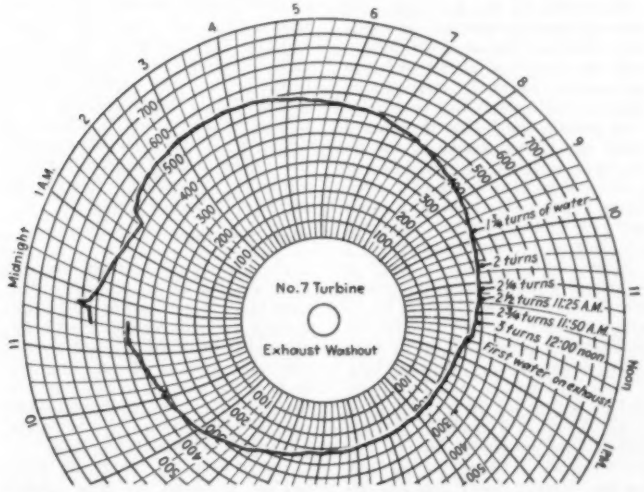
TABLE 10—WASHOUT INFORMATION ON No. 8 CONDENSING TURBINE

Date of washout	No. operating hours	Power generated, kwh	Average kw per hr	Full load capacity, kw Before washing	After washing
6-5-48	8,023	171,230,000	21,342	30,500	33,000
7-3-49	9,396	221,780,000	23,604	27,000	34,000
9-17-50	6,948	142,130,000	23,479	29,000	34,500

Turbine installed June 27, 1947.



Red curve is complete temperature record during washout cycle on No. 7 turbine. Black curve is operating steam temperature record of No. 6 turbine



Record of exhaust temperature during complete washout cycle on No. 7 turbine. The degree of water valve opening, and time opened, are shown at the right

Red temperature chart was recorded during washout of No. 6 turbine. Black curve is operating steam temperature record of No. 7 turbine

temperature of 210 F and a total temperature drop averaging approximately 100 F an hour.

Water was gradually increased to conform with washing requirements until the first indication of deposit appeared as shown under sample 1 of the tabulation of conductivity readings in Table 9. Various conductivity samples were taken during a 2.25 hr washing period; resistance was measured with an a-c Wheatstone bridge until two successive samples with a resistance of 25 ohms were obtained to compare with the inlet washout water of 30 ohms. Detailed information regarding the testing of samples appears in Table 9.

The water flow was gradually decreased until completely closed, permitting the temperature to rise. A natural increase in temperature continued with the 540 F temperature steam for a period of 2 hr 20 min at an average of approximately 105 F per hr reaching a maximum of 500 F temperature. At this point, high pressure steam was admitted at a temperature of 830 F and mixed with the 540 F temperature steam, reversing the procedure as explained while decreasing temperature.

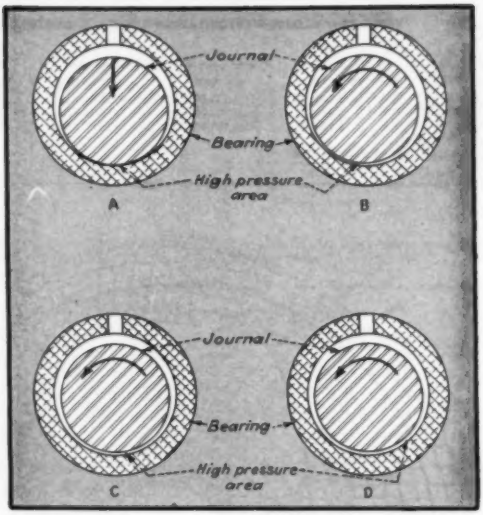
The steam pressure and temperature were customarily raised to the normal operating conditions with the machine speed gradually increasing until synchronous speed was reached. The entire washing period, minor cleanup of brush rigging and safety tests included a total of 15 hr. Compiled information regarding this washout is shown under date of 8-21-49 in Table 1.

The time required to wash the three units varies due to individual machine characteristics. When necessary, expansion readings are taken at frequent intervals during the washout periods. After resuming operations, the load increases are limited to 1,000 kw each and every 15 min until full load has been attained.

Editor's Note: This is the first of a series of articles presenting field data on the removal of deposits from steam-turbine steam passages. Subjects are:

1. Removal of water-soluble deposits by shutdown.
2. Removal of water-soluble deposits by light-load operation.
3. Saturated steam wash by water injection.
4. Hot water wash on turning gear.
5. Saturated steam wash under load by lowering boiler temperatures.
6. Caustic soda wash for removal of water insoluble deposits.
7. Acid cleaning.
8. Removal of water insoluble deposits by increasing steam temperature.
9. Mechanical cleaning during internal inspection.

Fig. 1—Formation of oil film as journal moves from rest to operating speed. To maintain this film, oil viscosity must be correct for service conditions encountered



- Viscosity must be right for conditions
- Check requirements with oil supplier
- High speeds usually require light oil
- Conversely, heavy oil for low speeds
- Influencing factors are bearing loads, clearances, heat, moisture, presence of abrasives, getting oil to the bearings
- Keep to a planned maintenance schedule

THOMAS TRAIL

BEARING LUBRICATION . . . . HOW TO DO IT

ADEQUATE LUBRICATION of bearings demands selection of the proper lubricant, its application at the proper time and in the proper quantity, and scheduled inspection and maintenance. This will minimize production delays, reduce operating costs and help prevent excessive wear of mechanical parts.

Oil reduces friction and minimizes wear of metal surfaces by forming an oil wedge or film between the rotary and stationary members. As shown in Fig. 1*A*, metal-to-metal contact occurs at the bottom of the bearing when the journal or shaft is at rest. As the journal begins to revolve, Fig. 1*B*, an oil wedge forms, which tends to lift the journal off the bearing surface. Then, the forces of the journal's weight and motion tend to seek equilibrium with the forces maintaining the wedging action of the oil; this causes the journal to move to the position shown in Fig. 1*C*. When the journal reaches full speed, forces of equilibrium cause it to shift, moving the high pressure oil area to position in Fig. 1 *D*.

Proper lubrication of such bearings therefore depends upon the formation of an adequate oil wedge or film. To obtain it, viscosity of the oil must be correct for the conditions encountered. When oil of proper viscosity is used, the force of adhesion of the oil film to the metal surfaces will be balanced by the force of cohesion between the molecules of the oil.

If too heavy an oil is used, the degree of adhesion of the oil film to the metal surfaces will be overcome by the greater force of cohesion between molecules of the oil itself, resulting in failure of the oil film to keep the metal surfaces apart.

Should the oil be too light, the force of cohesion between the molecules of the oil will be insufficient to build up enough of an oil wedge to support the journal; consequently, metal-to-metal contact will occur.

In general, the higher the journal speed, the lighter should be the oil employed, since the higher speed will permit a lighter oil to build a sufficiently strong wedge. Also, such an oil will have greater adhesion to permit it to cling to the journal surface.

When journal speed is lower, a heavier oil will be required. Its greater cohesion qualities will permit an oil wedge to form, while its adhesion qualities will permit the oil to cling to the slower moving journal surface.

Additional factors must be considered in determining the proper viscosity oil for use in a particular bearing. Included are pressure or bearing load and clearance between journal and bearing. Heavier loads generally require heavier oils; greater clearances necessitate heavier oils to prevent their escape from the bearings. Additional influencing factors are heat, moisture, presence of abrasive dust and other operating conditions.

Wherever possible, oil and lubrication procedures recommended by the machine builder should be followed. If such information is not available, authoritative advice may be obtained from lubricant manufacturers.

Grooving the inside circumference of some journal bearings aids in distributing the oil evenly over journal surfaces. This also helps to prevent excess oil being forced out of the ends of the bearing. The edges of all such grooves should be chamfered, so as to prevent their acting as scrapers to destroy the oil film. The same precaution applies to sharp edges of the bearing lining, or protruding shims in the case of split bearing linings.

Plain Bearings

In plain journal bearings, the flow of lubricating oil is generally sufficient to flush out dust or grit; consequently, periodic cleaning is not necessary unless hardened or caked deposits clog oil grooves or adhere to the surfaces of the journals or bearings. Under such conditions, carbon tetrachloride or mineral spirits should be employed to flush the bearing clean.

Several types of lubricating methods are employed on plain journal bearings. Included are the spring bottom or pump-type hand oiler, gravity feed oilers, and wick oilers. However, much better results are generally obtained by using thermal oilers or bottle oilers.

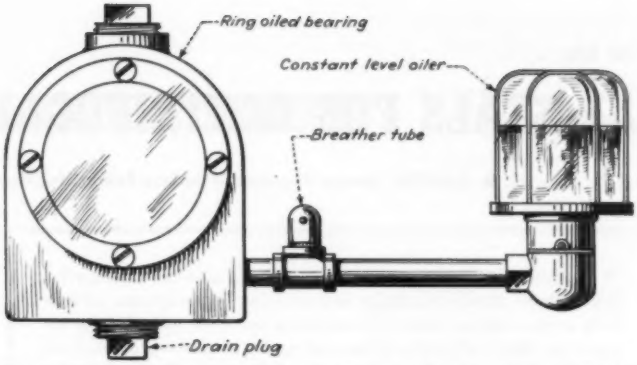


Fig. 2—Glass or plastic constant-level oilers are best insurance against inadequate supply of oil in bearings fitted with ring, chain or fixed collar for lifting lubricant from reservoir to top of bearing. Breather tube should be used outside vacuum area when conditions cause suction through the bearing

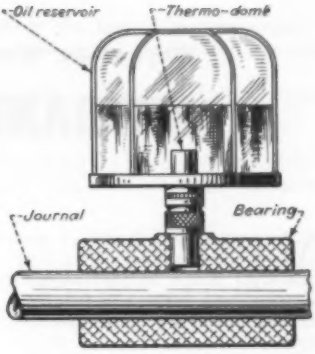
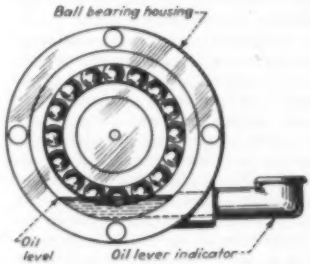


Fig. 3—Thermal oiler where heat from bearing expands air inside the container, forcing oil to the bearing

Fig. 4 (Right)—Maintain correct oil level for ball and roller bearings as shown here



WITH OIL

The thermal oiler, Fig. 3, operates on the principle that heating of the bearing causes expansion of the air inside the oil container, thus forcing a few drops of oil into the bearing. Formation of an oil film between the journal and the bearing causes cooling of the bearing, thereby stopping the flow of oil.

The bottle oiler is similar to the thermal oiler, except that it is equipped with a plunger that rests on the surface of the journal. The rotating journal surface causes the plunger to vibrate, thus releasing oil to the bearing. An increase in bearing temperature thins the oil and increases the flow.

Of course, rate of lubricant application and bearing cleaning (where necessary) depends on operating conditions. However, oiler reservoirs should always be kept adequately supplied with oil while the bearing is operating, and the feed should be kept properly adjusted to maintain a full oil film on the journal surface during operation.

Ring-oiled Bearings

Many journal bearings, especially in electric motors, are ring-oiled. A ring, having a larger internal diameter than the diameter of the journal, rests on the journal through an opening in the bearing top and rotates with the journal. Since the lower part of the ring is immersed in oil contained in the bearing reservoir, oil is carried to the top of the bearing and flows by gravity down through the bearing and into the reservoir again. This action assures an ample supply of oil, provided the oil level is maintained at the proper point.

For slower speed journal bearings a chain is substituted for the ring. The chain has greater oil carrying capacity, thereby supplying more oil than a ring revolving at slow speed.

Where the journal rotates at exceptionally high speed, a collar attached solidly to the journal is employed for oiling, since the journal would tend to slip under a ring and not move it.

The oil level in ring, chain and collar-oiled bearings should be checked once a week under ordinary conditions of operation. If the level is more than 3/16 in. below the top of the level gage, oil should be added to bring the level to within ⅛ in. of the top.

The shaft should always be stopped when checking oil level or adding oil to any type bearing. This will insure accurate level indication in the gage, and prevent overfilling and overflowing of the bearing.

Ordinarily, once a year such bearing housing should be drained of old lubricant, flushed with warm thin oil, and refilled to the correct level. Drain plugs or other fittings should have their threads coated with oil proof paint before they are replaced in the bearing housing.

Glass or plastic constant-level type oilers, Fig. 2, are the best insurance against inadequate lubricant supply in bearings of this type. These show visually when the oil supply is low, and maintain exactly the proper level of the oil in the bearing housing. They should be cleaned when the bearing is cleaned.

Packed and Wick Oiled

Some journal bearings are oil lubricated by means of oil-saturated wool packing that surrounds the bearing and conducts oil from the bearing reservoir to the journal by capillary action. The oil level in such bearings should be checked monthly. Oil is added slowly until it shows at the overflow hole located in the bearing housing.

Cleaning procedure is the same as for ring-oiled bearings, except that the wool packing should be removed from the housing, rinsed in thin oil to remove entrapped grit, squeezed dry, and carefully replaced in the housing.

The same type oiling devices may be employed on these bearings as on ring-oiled bearings, the level being carried just below the overflow hole in the bearing housing.

Small motors often have wick-oiled bearings. Here, a small wick, placed in a tubular reservoir containing oil is spring-held against the journal surface,

(Continued on page 111)

Why, When, Where to Use . . . .

MECHANICAL SEALS FOR CENTRIFUGAL

D. R. RANKIN, *Design Engineer, Peerless Pump Div., Food*

MECHANICAL SEALS are now operating satisfactorily on many centrifugal pumps. Included are units pumping light fractions in refineries, abrasive slurries, and all types of light and viscous liquids.

Seals have solved the toughest jobs and are also used on the cheapest types of pumps sold in great volume. Therefore, there is every reason to believe that as time passes, pumps between these two extremes will be built specifically for mechanical seals.

At present there is no satisfactory mechanical seal for process services where temperatures of the seal exceed 450 F. All successful mechanical seals have resilient components made from a variety of synthetic materials, with unique properties as required for the service. Normal low-cost oil resistant synthetics cannot be used for continuous operation in excess of 250 F. For temperature up to 450 F, it is necessary to use a material such as tetrafluorethylene resin, one of the newest plastics which offers high resistance to heat, chemicals and moisture. Cooling devices have been arranged to maintain the fluid next to the seals below these critical temperatures; consequently, liquids with temperatures appreciably greater than the maximum stated above can be pumped.

There is nothing definite in sight today indicating that seals will be available for temperatures above 450 F, which leaves an important gap uncovered by mechanical seals. However, projecting the rapid progress which has been made on synthetic materials over the past ten years, it is reasonable to assume that resilient materials may be developed for use in temperatures up to 800 to 850 F in the near future. It is also possible that seal designs which eliminate the critical resilient elements will be developed; however, none are offered commercially today.

Realizing that one of the big prob-

• Restricting leakage around rotating shafts of centrifugal pumps has been a major problem for design engineers and plant engineers, particularly in the chemical industry. Even though much has been done to improve the design of stuffing boxes and quality of packing, efforts have been made for years to develop successfully mechanical sealing elements for replacing packing.

Some plants have had discouraging experiences with mechanical seals, while in other plants the contrary is true and the seals are being used with increasing success.

As is true with almost all developments of this type, responsibility for failures can often be placed upon operators and plant engineers who do not fully understand either the equipment or its application.

Better understanding of the problems and characteristics of mechanical seals should therefore be helpful, not only for those operators who believe they know the answers to their pump problems, but also for those who have had adverse experiences with these seals. Hence, this article.

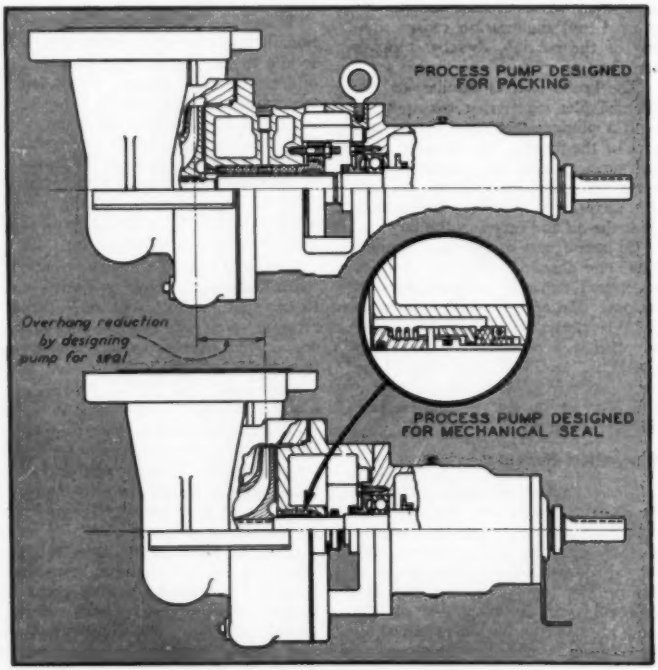
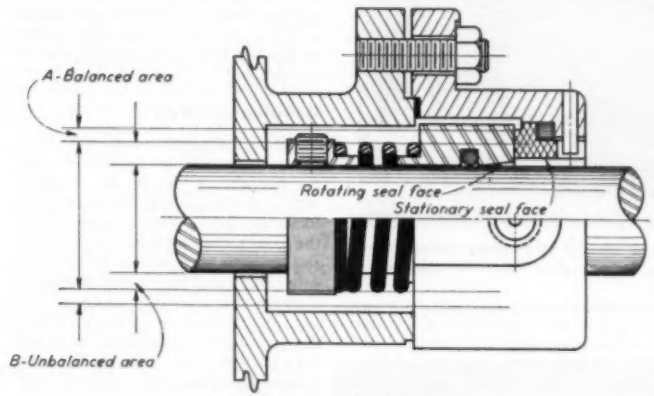

PROCESS PUMP DESIGNED FOR PACKING
Overhang reduction by designing pump for seal
PROCESS PUMP DESIGNED FOR MECHANICAL SEAL

Fig. 1—Pump designed for a seal has impeller much closer to the pump bearing, which reduces shaft deflection due to runout or side forces developed by hydraulic thrust on the impeller

PROCESS PUMPS

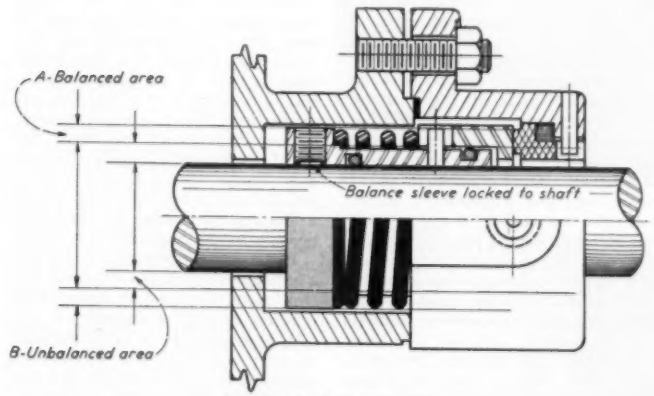
Machinery & Chemical Corp.

- **Seals of standard materials are limited to temperatures below 250 F. For higher temperatures, use special materials**
- **Users should make sure proper seal material and correct seal are employed for each application**
- **Use unbalanced seals up to 75 psi for fluids with good lubricating qualities; balanced seals for higher pressures**



UNBALANCED SEAL DESIGN

A—Forces resulting from stuffing box pressure applied over balanced area equal to pressure forces tending to separate seal faces
B—Forces resulting from stuffing box pressure applied over unbalanced area carried by seal faces acting as a thrust bearing



BALANCED SEAL DESIGN

A—Forces resulting from stuffing box pressure applied over balanced area equal to pressure forces tending to separate seal faces
B—Forces resulting from stuffing box pressure applied to balance sleeve which transmits force through shaft to pump thrust bearings

Fig. 2—Essentially, on an unbalanced seal the force resulting from the pressure on the rotating ring is carried by the seal faces acting as thrust bearing. On a balanced seal, most of the force is taken by a sleeve firmly attached to the pump shaft, transmitting force to pump thrust bearing. Both designs are illustrated here

lems in a process plant is to get a pump back on the line if a seal fails, some manufacturers have built up seals in cartridge form which permit them to be checked on test prior to installation on the pump. When this is done, the critical lapped wearing faces and O-ring resilient elements do not need to be disturbed when installing the seal on the pumping unit. The only joints which have to be made are between the sleeve and the shaft and between the flange and the pump housing so that there is normally very little chance of the seal not working when it is put into the line.

As mechanical seals prove themselves in various applications, more pumps are designed specifically for use with them. A pump designd specifically for use with a seal is a better machine than a pump designed for packing with a seal added later. Since seal face rings must be installed over the end of the shaft, it is not possible to work on a seal without removing the pump impeller. Thus, the working area behind the packing container and the bearing of the pump is not required when seals are used. The length of a mechanical seal is normally appreciably less than that of packing.

A pump designed specifically for a seal, as shown in Fig. 1, has the impeller much closer to the pump bearing, greatly reducing the shaft deflection due to runout or side forces developed by hydraulic thrust on the impeller. It is also less expensive to manufacture a pump specifically for a seal than to make a pump for packing and later adapt it for a seal usage. Thus, it is highly desirable to purchase a pump which is specifically designed for seals rather than merely adapt seals to existing designs.

In purchasing a pump with a mechanical seal it is just as important to see that the pump construction is such that it is easy to replace the seal as it was in purchasing a stuffing box type pump to see that there was ample room to get in around the shaft and add more rings of packing or to repack the pump. On some pumps it is possible to get at the seal by simply removing an end plate and the impeller. On many general service process pumps the rotating element can be removed

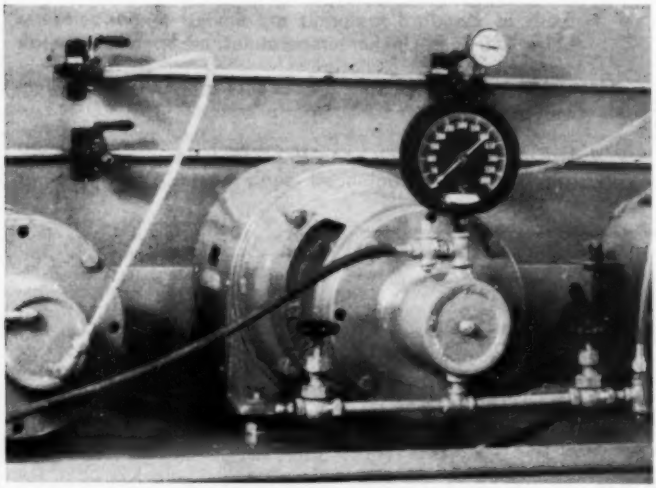


Fig. 3—Inexpensive test unit checks circulation of fluid at pumping temperature; also, correctness of seal materials and faces for any given industrial application

without disturbing discharge piping and the seal removed after taking off the impeller. However, on some pumps it is necessary to take the unit into the shop and pull bearings or to completely disconnect the piping to get at the parts which will permit replacement of the seal. Such construction should be avoided whenever possible.

Since mechanical seals are relatively new, it is important to recognize the differences between them. The basic construction of mechanical seals varies widely and frequently operators become discouraged because they do not have initial success when their basic problem is misapplication of the type of seal.

Temperature Limits

Mechanical seals which have Neoprene, Hycar or synthetic rubber elements of similar characteristics cannot be operated above 250 F. Thus, seals with O-rings or bellows of this material can be used only within that temperature range. Seals with materials resistant to temperature between 250 and 450 F are more expensive and normally require chevrons or tapered wedges which must be of large diameter to provide correct resilience and operation of the seal.

Most seal manufacturers make both unbalanced and balanced seals. Unbalanced seals are less expensive, usually are not made in cartridge form so that they are pre-tested, and should not be used where the pressure on the seal exceeds the manufacturer's rating. When unbalanced seals are used at pressures in excess of 75 lb differential across the seal, the lift of the seal is appreciably reduced. Normally, unbalanced seals should not be used at pressures above 125 lb, even for intermittent operation, as the faces may gall, particularly with poor lubricating fluid being handled in the sump.

Balanced Design

A balanced seal is one so designed that the pressure between the wearing faces of the seal remain essentially constant over a wide range of pressures on the seal. With properly balanced seals it is possible to go up to virtually any pressure and obtain excellent life. Standard balanced seals can be used for pressures of 400 and 600 psi without any special consideration; for higher pressures, it is wise to make sure that the seal manufacturer is familiar with your requirements so he will make certain that the seal is properly balanced for the required operating range. Obviously, the requirement that the stuffing box pressure be maintained on the packing gland is not necessary when balanced mechanical seals are used.

Engineers and operators frequently ask: "What does it mean when you say balanced seals"? Forces on balanced and unbalanced seals are indicated in Fig. 2. Essentially on an unbalanced seal the force resulting from the pressure on the rotating ring is carried by the seal faces acting as a thrust bearing.

On a balanced seal, most of the force which was carried by the seal faces is taken by a sleeve firmly attached to the pump shaft transmitting the unbalanced force to the pump thrust bearing. The diameter of the rotating ring in relation to this sleeve is so adjusted that there is as much pressure between the faces of the seal tending to open them as there is behind the rotating ring tending to close the faces. Exactly what happens between the seal faces is of no practical interest to engineers or operators. However, it is not a linear pressure drop and is not always the same for different fluids. The best way to balance a seal is simply to vary the diameter of the faces and operate the seal under a wide range of pressures, and measure the heating of the seal and power consumption of the driver.

Unbalanced Seals

On an unbalanced seal, the power consumption will go up directly with the pressure as would be expected with a given friction coefficient and increasing load. With a balanced seal the power consumption to drive the seal goes up very slowly as the pressure is increased over a wide range, indicating that it is very nearly in balance. Normally it is desirable to have the seal slightly unbalanced so it will tend to close as the pressure increases, thereby preventing the seal from opening on a pressure surge; however, at no time over the pressure range does it exceed the proper bearing unit pressure between the seal faces.

With light hydrocarbons where relatively high suction pressures exist, and for applications where poor lubrication quality exists in the fluid pumped, it is highly desirable to use balanced seals. Many users standardize on balanced seals because then they do not need to worry if the pump with the seal is transferred to a different operation with higher suction pressures.

It is often important to verify that a seal can be used to handle a particularly "tough" fluid; however, operators hesitate to experiment on pumps in the process because of their relationship to the operation as a whole.

It is relatively inexpensive to build a testing device which will permit (1) circulation of a fluid at process temperature through a dummy pot and (2) operation of an actual-size seal at pump speed, thereby determining whether or not the materials used and faces are correct for the application. This same test apparatus can be used to check cartridge-type seals before they are put in warehouse stock. Such testing apparatus, which can be used either in the maintenance shop or in connection with the application of seals to pumps in the field, is illustrated in Fig. 3. Such a test apparatus can often be borrowed from seal

(Continued on page 117)

STUDEBAKER'S DYNAMOMETER SUPPLY GETS PRECISION D-C VOLTAGE REGULATION

When extremely steady voltage conditions were required, regulator sensitivity was increased to plus or minus 0.10 v, with the response time of two or three cycles, on a 250 v supply. Here are the various systems considered, their sensitivity, and the means by which it was obtained

E. G. MOREHOUSE, *Electrical Engineer*, and **J. W. STRUMPFER**
The Studebaker Corporation

WHEN STUDEBAKER Corporation installed its electrical distribution system* more than a year ago, it was known that an extremely steady source of d-c power would be required to supply the dynamometers in the engine test laboratories. There are several of these machines, rated at 100, 150 and 200 hp, running intermittently. Consequently, severe variations in load were expected.

Need for isolating each machine from effects of load changes caused by others is so great that a synchronous motor-generator set for each dynamometer is justified. However, a properly regulated and filtered rectifier power supply could do the job and could be installed with considerable saving in investment, space and operating costs, even when compared to the minimum number of two MG sets (needed for continuity of power and for isolation).

Other advantages expected from the ignitron rectifiers were greater speed of response, ability of the ignitrons to take heavy momentary overloads, and ease in replacing parts liable to failure.

In an engine test run, the dynamometer is first driven as a generator and loaded by a grid resistance. During this run to obtain fuel consumption and power output, the machine is isolated from the d-c power supply. Immediately afterwards, however, the friction run is made and the dynamometer is connected to the power supply as a motor, driving the test engine in order to obtain losses. Runs are made at speeds ranging from 400 to 4500 rpm. It is during this test that changes in the voltage are so critical.

Torque is proportional to the difference between the applied voltage and the sum of the counter emf and the brush drop. Since, under steady state conditions, this value may be less than a volt, a sudden change of even 2 or 3 v in the applied voltage causes

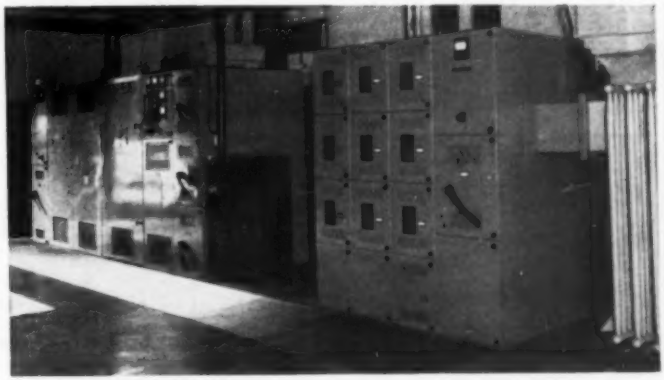


Fig. 1—This substation supplies d-c power to the dynamometers used to test output and friction in Studebaker auto engines

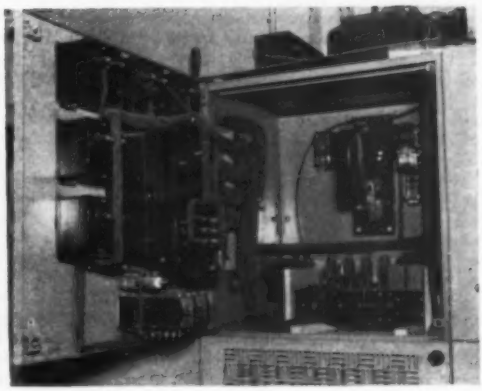


Fig. 2—Interior of the regulator compartment shows the temporary installation of electronic equipment. This will be replaced with a permanently installed panel

* Studebaker's New Power Distribution System — INDUSTRY AND POWER Septetmber, 1950

EDITOR'S NOTE: E. L. Hulla and T. H. McGreer, of the Westinghouse Electric Corp., which supplied the equipment, were field engineers on the job. They have coauthored technical papers on the subject with the Studebaker engineers.

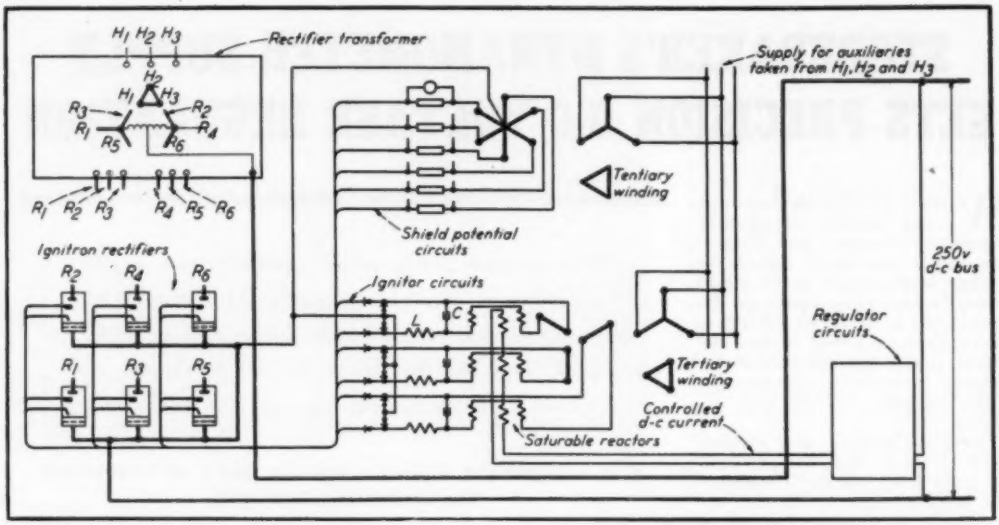


Fig. 3—Ignitrons use a six phase connection. D-c bus output potential is fed to regular circuit, which controls d-c input to saturable reactors. These in turn control the phase shift of discharge of the L-C circuit in ignitor line

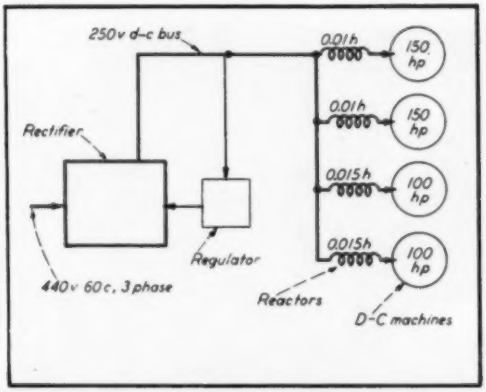


Fig. 4—Single line diagram of the rectifier power system for dynamometers gives reactor values used in motor lines

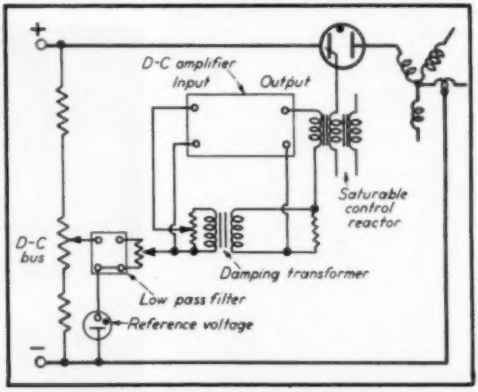


Fig. 5—Schematic diagram shows principle elements of the final electronic regulator system as installed in Fig. 2

wide variations in torque before speed and counter emf can change correspondingly. Tests show that changes of a few tenths of a per cent in voltage may result in measured torque errors of 20 per cent or more, depending on the constants of each dynamometer.

Previous experience with motor generator sets showed that the steadiness of the output was not entirely satisfactory. Torque variations in the neighborhood of 12 to 16 per cent were obtained.

At the time of the installation of the distribution system, the engineers felt that the ignitron rectifier was the best available answer to the voltage problem. From the start, trouble was expected with mechanical regulation because of its inertia. However, a mechanical regulator was installed in the ignitron power supply until a suitable electronic system could be developed.

As had happened on motor generator sets, when a load change on one dynamometer upset the voltage, the operator of another machine in a separate room attempting to readjust the input only added to the confusion.

Previous experience with motor generator power supplies did not indicate the extent to which variations in the a-c input could effect the torque readings. There are large numbers of resistance welders, as well as other equipment, that cause voltage disturbances on the a-c system. Although the new distribution system is designed to carry these loads with capacity to spare and still maintain the voltage variation well within the limits for any ordinary situation, even the minor variations of only 2 or 3 v occurring one or two times per second are such that a mechanical type of regulator is capable of making only small correction.

The voltage regulation obtained with the mechanical type was better than plus or minus 1½ per cent with a speed of response of not less than several cycles. This regulation is quite satisfactory for most applications, such as a supply for d-c motors where inertia of the motor itself makes the

speed of response negligible in comparison. However, because of the amplifying effect of the dynamometers, better regulation and faster response were necessary.

An elementary diagram of the rectifier installation is shown in Fig. 3. The firing circuit employs saturable reactors to control the impulses to the ignitors of the tubes, and to shift the phase of the impulses as necessary to control the output voltage. The regulator circuit, indicated by the box in the lower right hand corner controls the d-c supply to the saturable reactors as necessary. The reference voltage circuit is connected across the d-c output buses and originally contained the control coil and adjusting potentiometer for the mechanical regulator.

Actually, mechanical regulation was upset more by dynamometer load changes than was regulation on the earlier motor generator sets. This was because the inertia of the mechanical regulator was considerably less, allowing it to vary rapidly but not quickly enough to avoid a change in the dynamometer current. The result was an oscillation about the steady state condition which was greatly amplified in the torque measuring system of the dynamometer.

The first electronic regulator produced much better voltage control, particularly for steady state conditions. However, gas type tubes were used in the first system and their characteristics did not match those of the circuit itself and of the reference voltage circuit. Speed of response was still sluggish—of the order of 3 c.

When the regulator circuit was changed to accommodate vacuum tubes, speed of response was more than doubled. This is the type of regulator being used at present and undergoing final adjustment for the permament installation.

The output of the electronic regulator supplies the d-c coils of the saturable reactors, Figs. 3, 4 and 5, in the same manner as the mechanical type. The reference voltage circuit was simplified considerably.

After the rectifier was placed under control of the electronic regulator, it was found that the static sensitivity was plus or minus 0.1 v on the 250 v d-c system. However, due to fluctuations in the a-c supply, actual voltage variations had been reduced only to plus or minus 0.4 per cent, or plus or minus 1 v. Correction was completed in 3 to 5 c. Although these variations are considerably faster than the natural frequencies of oscillation of the dynamometer, some scale variation was still present.

An electronic regulator is sensitive but a slight delay in response time may still cause surges or oscillations which are objectionable in this particular application. Damping schemes may be used in the electrical circuit of the regulator. However, it is possible for the a-c input voltage to vary in such a manner as to either aid or oppose the damping voltage, and may even cause the regulator to overshoot appreciably.

Oscillograph curves of a test on the system are shown in Fig. 6. The lower trace is a recording of the a-c supply voltage. The upper trace shows variations in the d-c bus voltage. The high frequency "fuzz", caused by commutation in the ignitron circuit, is of no consequence in this application, being too fast to have any possible effect on the dynamometer. The longer swings covering most of the oscillogram are important.

The sharp break in the bus voltage curve was caused by switching a bank of capacitors on the 440 v a-c supply, causing a change of 12 v. On the d-c side, this caused a change of only about 1 v which was corrected in approximately 1½ c. In order to smooth out these swings in the d-c voltage, reactors were employed.

The constants of the regulator used in this application and the character of the load is such that the regulator permits an oscillation of the order of 0.7 v at a frequency of from 5 to 12 c per second. To effectively eliminate the ripple, the a-c voltage variation superimposed on the d-c output by the regulator action must be reduced by a factor of 10 at the lowest variation frequency of importance, approximately 5 cps, in order to limit scale pointer movement due to torque variation to ½ lb or less.

Individual reactors are mounted in the test cells and connected in the armature circuit of each machine. They are iron core inductances with an air gap, and are rated according to the power of the dynamometer. The inductances for the 100, 150, and 200 hp units are 15 mh, 10 mh, and 7.5 mh respectively. These values were chosen to give an impedance at 5 cps that is approximately 10 times the armature circuit resistance of the machine. An ohmic impedance of about the same value would produce about the same reduction in voltage swing but would cause excessive power loss near full load.

The center trace in Fig. 6 is the voltage at the dynamometer terminals with the reactor in the circuit. This shows how the reactor has smoothed out not only the sharp break caused

(Continued on page 117)

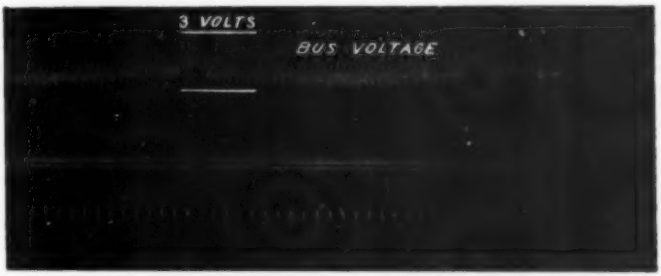


Fig. 6—Upper trace was taken on 250 v d-c bus ahead of reactors when 440 v a-c input was changed 12 v by added load. Reactors (center trace) minimize transient

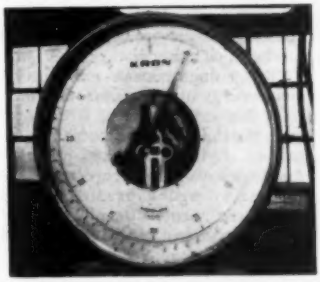


Fig. 7—Mechanical amplification of the dynamometer torque blurs readings

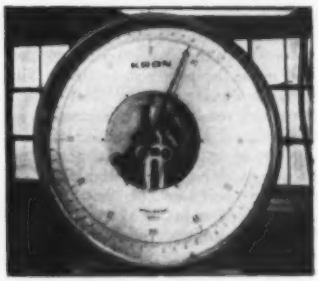
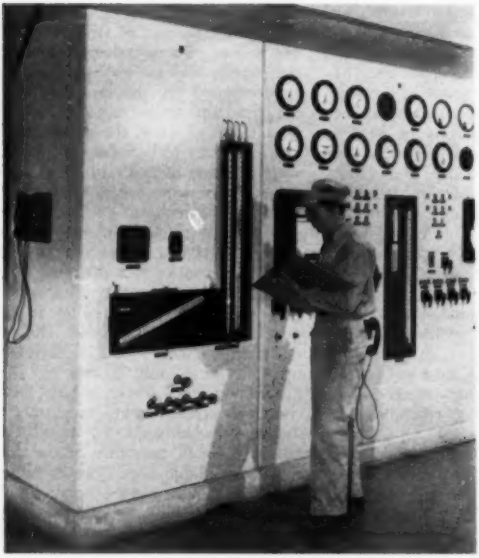


Fig. 8—Reactors reduce torque transients, allow accurate scale readings



Although internally cooled conductors have been introduced for very large turbine generators, standard methods are still being improved for use in the smaller units. Here is an up-to-date discussion of hydrogen systems with particular attention given to thrust bearing shaft seals, scavenging, hydrogen supply and operating means

A. LEHRKIND, *Motor-Generator Section*
Allis-Chalmers Mfg. Company

Fig. 1—The relatively simple hydrogen instrument panel at the left of the main panel reflects the reduction in operating controls in modern hydrogen cooling systems. Purity and pressure gages are principal supervisory instruments

Standard Methods Modernized in . . . .

HYDROGEN COOLING FOR GENERATORS

HYDROGEN COOLING of generators is simple, safe, efficient, and economical. This is ably supported by the excellent operating records of many units now in service. Successful operation of such machines has also resulted in a definite trend toward hydrogen cooling of all large, high speed alternators with indications that the system will be applied to smaller units in the future.

The primary advantage of hydrogen cooling is to increase generator efficiency. In high speed, air cooled generators, windage amounts to between a third and a half of the total losses, depending on peripheral speeds. As used for cooling, hydrogen has a density that may vary from one-fourteenth to one-tenth the density of air, depending upon the purity maintained. This reduces windage loss at least 90 per cent and results in a considerable increase in efficiency.

Cost of hydrogen cooled generators is not excessive because the high heat transfer coefficient of that gas permits reduction in the size of the generator and cooling equipment to partly offset added construction costs. Furthermore, increased efficiency is not the only advantage gained.

The explosion safe, gas-tight cylindrical shell reduces virbation and noise and eliminates external ductwork. Absence of oxygen eliminates insulation damage from corona and reduces the possibility of destructive fires within the machine. The gas-tight shell also prevents overheating caused by gradual dirt build-up in ventilating passages.

Advantages of Hydrogen

Hydrogen has desirable properties not found to the same extent in any other gas. In addition to the low density and high heat transfer properties previously noted, pure hydrogen has 14 times the specific heat of air. Helium, its nearest competitor in this respect, has inferior heat transfer rates and, since it is twice as heavy, would produce twice the windage loss.

Design improvements make hydrogen cooling of generators extremely safe. The outer housing is designed to withstand explosive pressures developed by hydrogen-air mixtures. Auxiliary apparatus and operating procedure are designed for safe operation and in the remote case of failure of any part, that part can be isolated and the remaining equipment kept in normal operation.

There are two safe common methods of admitting hydrogen into the generator housing. One is the vacuum scavenging method whereby the housing is evacuated to one-fifth of an atmosphere. Since no mixture of hydrogen and air will ignite at this pressure, the two gases can be interchanged directly, and the pressure can then be raised to normal by the admission of additional hydrogen.

Present practice in scavenging uses an inert gas. The process consists of displacing the air with carbon dioxide and, in turn, displacing the carbon dioxide with hydrogen, all at slightly more than atmospheric pressure. While this method requires larger quantities of gas, auxiliary equipment requirements are reduced.

Hydrogen pressure should be slightly greater than that of the ambient air to assure that any gas leakage will be outward. To allow for gage errors and variations in controls, a nominal pressure of ½ psig has been adopted as standard for normal operation. An increase to 15 psig permits 15 per cent overload on the generator without increase in temperature. Higher pressures permit additional loading.

Development of suitable shaft seals was one of the major problems to be solved before hydrogen cooling of generators became feasible. In developing

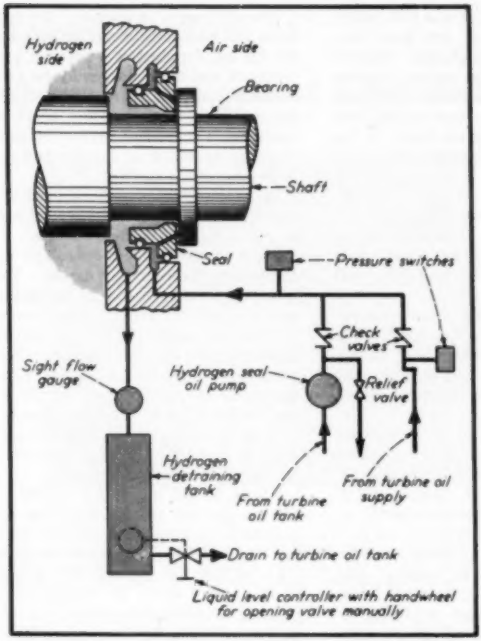


Fig. 2—The oil for lubricating, cooling and sealing is pumped to seal thrust bearing. A small amount reaches the hydrogen side. Entrapped gas is removed in detraining tank

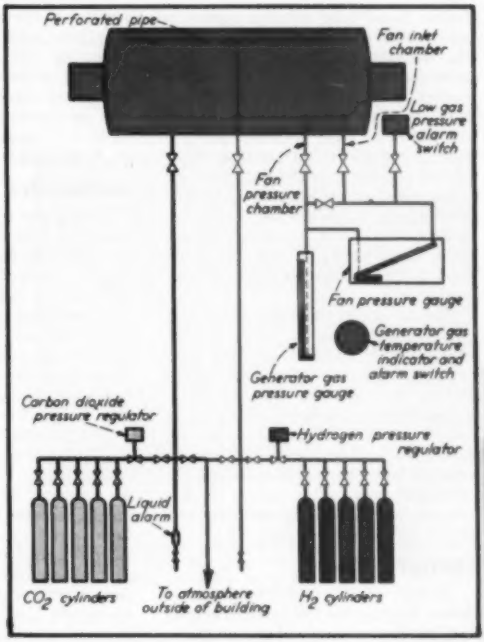


Fig. 3—Hydrogen tanks supply the few cubic feet daily required to maintain purity and pressure. Carbon dioxide gas from cylinders is used in one method of scavenging the air

the seals, it was found that, because of the high surface speeds, oil is required not only for lubrication of the seals and to make them hydrogen tight, but also for cooling them.

Since oil can absorb as much as 10 per cent of its volume of any gas with which it comes in contact, the necessity for using oil for the shaft seals posed the problem of keeping the dissolved air from contaminating the hydrogen atmosphere within the machine. The removal of each cubic foot of air brought into the machine can require the replacement of up to 50 cu ft of impure gas by fresh hydrogen to maintain the purity within the machine.

On most machines built before 1946, vacuum treating equipment had been provided to remove air from the oil. The thrust bearing type of seal, however, permits so small a quantity of oil to enter the hydrogen atmosphere that contamination is negligible. Since operating experience proves that vacuum treating is unnecessary with this seal, the equipment for it is no longer provided.

When hydrogen cooling of turbogenerators was first introduced, some installations were very complicated. There were too many auxiliaries, gages, and recording instruments to make it practical, efficient or economical. Operating experience and design innovations eliminated much of the special equipment and the accompanying excessive and unnecessary operating and maintenance expenses for the user.

Auxiliary Equipment

Necessary equipment for hydrogen cooling of generators having the thrust bearing seals is limited to the few items shown in Figs. 2 and 3. The shaft seal requires only 10 to 40 gpm of cool turbine oil, normally supplied by the main gear-driven pump with back-up protection furnished by steam and electric pumps. An additional motor driven pump, which starts automatically, is supplied to seal hydrogen during shutdown when the larger pumps are not in operation.

Apparatus needed to remove air from the housing and replace it with hydrogen, and for maintaining normal pressure and purity is shown in Fig. 3. The hydrogen is fed automatically as needed by a diaphragm operated regulator requiring no electrical connections. The instruments are for supervision only, and alarms are furnished for low pressure, high temperature, and for liquid in the housing.

With carbon dioxide scavenging, a hydrogen purity of 98 per cent is obtained initially. Leakage of gas is sufficient to balance the small amount of air carried in by lubricating oil, and a flow of a few cubic feet of pure hydrogen then maintains a purity of about 96 per cent in the housing. In normal operation, hydrogen is supplied automatically to hold running pressure.

Differential pressure gages indicate hydrogen purity. These gages measure the pressure developed by the generator cooling fans. Since the fans run at constant speed, pressure developed is directly proportional to gas density, which in turn is determined by relative proportions of hydrogen and air in the housing. In practice, two differential gages, both oil filled U-tubes, are usually provided.

Purity Gages

One is inclined and graduated to provide direct reading of the hydrogen purity when the generator is operating at the normal pressure of ½ psig. The other is vertical and is used for higher gas pressures and for test. Its pressure readings, used in conjunction with the machine gas pressure gage readings, are converted to percentage of hydrogen by means of a graph.

Essentially, the seal consists of a

babbit faced ring bearing against a shaft collar or runner. The design of the seal assembly, shown in Fig. 4, is such that the seal oil loads the bearing surface in proportion to pump pressure, thus limiting the flow of oil past the seal face. Also, since the hydrogen side of the seal is the smallest radius of the seal face, centrifugal force opposes the leakage into the generator atmosphere. Thus, oil flow to the hydrogen side is only a few gallons per hour, which passes through the oil return of the seal assembly to a detraining tank.

Toward the outer radius of the seal ring, the seal face is commonly divided into segments by radial grooves. This segmental portion is separated from the inner continuous flat face by a circumferential oil distribution groove. The segmental sections support the thrust load, while the radial grooves provide an adequate flow of oil for cooling the seal. This cooling oil discharges into the bearing enclosure and drains off with the bearing oil.

Emergency Seal

Springs, which supplement oil pressure in keeping the seal surfaces in contact, can maintain a good seal at standstill without oil pressure for short periods of time if gas pressure is low.

With the development of the thrust bearing type of seal for hydrogen cooled generators, need for vacuum treating of the seal oil was eliminated. Machines built 11 yr ago have been operating since installation without need for or use of the vacuum treating equipment furnished. Such equipment was not provided on some of the units built 8 yr ago, and on none of the units produced within the last 4 yr.

Maintenance

Thrust bearing seals require inspection each 3 to 5 yr, at which time replacement of some gasket materials is usually needed. The hydrogen seal auxiliary oil pump should be opened for inspection at the same time although, if oil filters are performing properly, no work should be required. Pressure switches should be tested occasionally to assure operation when they are needed.

The gas system requires replacement of empty hydrogen cylinders about once a week. Pressure regulators are, of necessity, sensitive devices which may be damaged by improper handling. Consequently, spare regulators are provided to permit normal operation while repairs are made. The pressure and purity instruments, on the other hand, are simple U-tube gages requiring infrequent addition of oil or mercury. They are self-calibrating.

A set of alarm lights operated by pressure switches in the oil and gas systems require occasional lamp replacement under ordinary conditions.

The oil supply is normally obtained from the turbine oil line. In the past, the oil was supplied at a pressure sufficient to seal the hydrogen in the generator at pressures up to 3 psig. Now, because higher gas pressure overload operation is permitted, oil for the seals must be provided at correspondingly high pressures.

A stand-by pump automatically maintains seal pressure in case of loss of pressure in the turbine oil line.

Most of the seal oil discharges directly into the bearing drains. The trickle of oil that flows past the hydrogen side of the sealing faces enters a detraining tank, Fig. 2, for gravity separation of oil and hydrogen. The oil slowly flows out through a float valve and U-tube trap and returns to the turbine oil tank. The hydrogen returns to the generator through the seal drain pipes or through a separate vent pipe provided for the purpose.

About 40 gal of oil are needed to fill the seal oil system. Oil flow requirements per seal vary from 10 gpm for a 15,000 kw generator to 40 gpm for a 100,000 kw machine. Oil is supplied at about 40 C. The highest temperature in the sealing system, including the seal itself, does not exceed 90 C.

Because of the improved and simplified hydrogen control system, hydrogen cooling of generators has virtually eliminated air cooling for high speed turbine generators above 15,000 kw

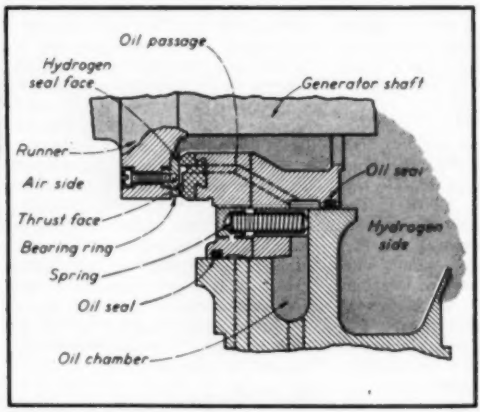


Fig. 4 (Above)—Oil passages and chamber are designed for cooling and sealing, and to load the seal ring in proportion to oil pressure. Springs keep sealing surfaces in contact and retain low gas pressures without oil pressure in case auxiliary pump fails when generator is not turning

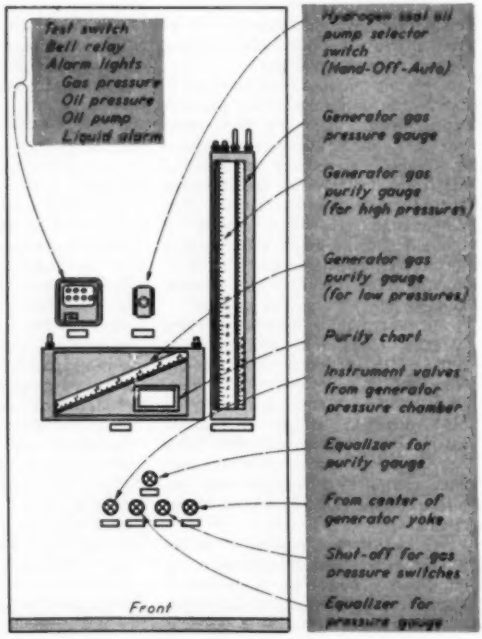
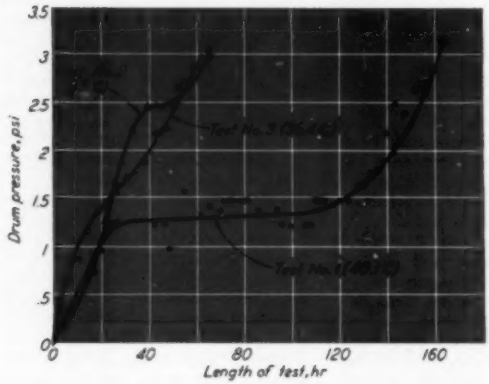
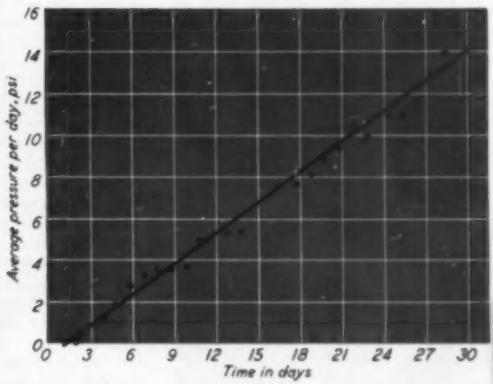


Fig. 5 (Right)—Instruments and controls on the panel are for supervision only. The low pressure purity gage is inclined for greater accuracy. Alarm lights, in case with test switch, are for locations or conditions listed. The valves at the bottom are in the instrument pressure lines

Materials for engineered plant services

Types and applications of materials that help to solve problems involving corrosion, abrasion, heat and pressure





Strong sulfuric acid stored in steel drums results in generation of hydrogen and pressure build-up. Shown here are results of tests where a 55 gal drum, containing 50 gal of 93 per cent sulfuric acid, was held at a temperature near 40 C. Left: Drum pressure released three times where curves stop. Right: Pressure build-up during 30 day test

CONSTRUCTION MATERIALS THAT STOP SULFURIC ACID CORROSION -- 2

Corrosion problems with cast iron and steel can be solved by recognizing limitations of these metals and designing away their weaknesses. Inhibitors also help to stifle attacks by this acid

S. W. SHEPARD, *Materials Engineer, American Cyanamid Company*

CAST IRON AND STEEL have been used in great quantities for handling strong sulfuric acid and could probably be used more widely than they are if their limitations were recognized and a real attempt made to design away from their weaknesses. The corrosion rates are sufficiently low for room temperature use of cast iron and steel in sulfuric acid at concentrations from about 60 up to 100 per cent. However, they are commonly used only in the range of about 80 to 100 per cent largely because of the possibilities of dilution and subsequent vigorous corrosion.

Cast iron and steel depend for their corrosion resistance to sulfuric acid on film formation on the surface. As long as this film is kept intact and acids are actually kept at high strengths, the films on cast iron and steel are quite stable and the corrosion rates are low. However, when these films are abraded off or weakened, corrosion can proceed quite rapidly.

Considerable difficulty has been encountered in steel storage tanks and steel drums storing strong sulfuric acid. When precautions are not taken to allow for the escape of the hydrogen generated, considerable pressure can develop. This is shown by the accompanying graphs. The one at the left shows the results of a test where a 55 gal sulfuric acid drum was kept at about 40 C containing 50 gal of 93 per cent sulfuric acid. It was fitted with a pressure gage. The chart indicates that the pressure reached 3 psi in about 60 hr. In another similar test the drum was found to develop pressures as high as 15 psi in 30 days.

The most common difficulty that has been encountered with sulfuric acid storage tanks has been vapor phase corrosion. Wet air enters the tank as it is emptied, the moisture is absorbed by the film of sulfuric acid on the walls and so dilutes it that the steel corrodes rapidly. The life of these tanks can be extended considerably if a thicker shell section is used in the top to allow more wastage, or if the tanks are designed so they can be turned 180 deg, so that a comparatively unattacked surface can again be exposed to the vapor phase corrosion. This vapor phase corrosion is also accelerated by the high temperatures developed during the day by direct exposure to the sun.

This condition can be alleviated somewhat by applying a reflective finish to the outside, insulating the top part of the tank or building a shed over it. There is an indication that the ap-

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Abstracted from a report of the National Association of Corrosion Engineers Technical practices Committee 5A of which Mr. Shepard is chairman. He presented this report earlier this year at the N.A.C.E. Seventh Annual Conference and Exhibition, New York, New York.

I&P AGAIN EXPANDS EDITORIAL STAFF

Announcement was made in the November issue of the addition of Jack E. Hinkley to the editorial staff of I&P. This month we're pleased to announce that Arthur M. Steinmetz also has joined I&P editorial staff.

Arthur M. Steinmetz

Mr. Steinmetz comes to INDUSTRY AND POWER with a wealth of diversified experience in the field of Engineered Plant Services. He will contribute greatly to the ever increasing service INDUSTRY AND POWER offers to you and its many thousands of other readers throughout American industry.

A graduate of Stevens Institute of Technology, Hoboken, New Jersey, Mr. Steinmetz received his M. E. in 1936. After graduation, he took a position as student engineer with the American Blower Corporation in Detroit, Michigan where he received instruction in the research and development department, testing laboratory, engineering department and various sections of the production department. From 1937 to 1940 he was Field Engineer for the same company in Boston. Here he engineered equipment for pneumatic conveying, drying, industrial heating, industrial process ventilation and mechanical draft. In special cases, such as fly ash collection, Mr. Steinmetz directed surveys and tests in industrial plants to determine from flue gas samples the size and concentration of dust particles. He was transferred to the Power Apparatus Department of American Blower Corporation in New York. Here, from 1940 to 1942 he specialized in design and application of power plant equipment for boiler manufacturers and consulting engineers. The equipment consisted of mechanical draft fans, dust collectors, hydraulic couplings and steam air heaters. Mr. Steinmetz supervised erection of this equipment where necessary and service after installation. The next year, 1942 to 1943, was spent in applying fan equipment for diversified industrial processes including food dehydration, aircraft testing and fume and dust removal. One phase of his work included fan and blower designs involving abnormal temperatures, densities and pressures.

From July, 1943 up to his coming to INDUSTRY AND POWER, Mr. Steinmetz was Staff Engineer, Plant Service Department of Thomas A. Edison, Inc., West Orange, New Jersey. This position covered all technical aspects of power plant operation, electrical distribution, maintenance and design. Design work included preliminary engineering, purchasing, installation, initial operation and maintenance of all specialized equipment such as automatic combustion controls, feedwater controls, pump governors, metering units and coal weighing equipment.

L. E. Quist

Publisher

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plication of a phenolformaldehyde protective coating in the vapor phase might be helpful and the use of a vapor phase inhibitor is also being investigated.

Cast iron has excellent resistance to concentrated sulfuric acid but its use has been avoided in acid containing any appreciable amount of free SO_3. It has been found that this SO_3 combines with silicon, resulting in high stresses and cracking of the cast iron and in some cases this cracking takes place with explosive violence. By purchasing dense, close grained cast iron with a maximum of 1 per cent silicon American Cyanamid Co. has used cast iron sulfonators with oleum for many years with no sign of cracking. They have been used in concentrations of free SO_3 that are known to be very corrosive to steel. The corrosion rate of the cast iron has not proved to be excessive.

LIMITING CONCENTRATIONS FOR VARIOUS TYPES OF STAINLESS STEELS

A.I.S.I. stainless steel	*Temp.*	*Acid concentrations*
Types 430, 302, 303, 304, 321, 347	Room	Below 0.50% and above 90%
Types 309, 310, 446		Below 5.00% and above 90%
Types 316, 317		Below 20.00% and above 90%
Types 430, 302, 303, 304, 321, 347	Below	Below 0.10% and above 95%
Types 309, 310, 446	150 F	Below 1.00% and above 95%
Types 316, 317		Below 5.00% and above 95%
Types 309, 310, 446	Around	Below 0.01%
Types 316, 317	200 F	Below 0.50%

Corrosion Inhibitors

Cast iron and steel are not commonly used as materials of construction for handling dilute sulfuric acid. However, there are many organic materials that act as corrosion inhibitors which permit the use of steel with useable low corrosion rates. American Cyanamid Co. has been adding organic inhibitors to sulfuric acid solutions of from 5 to 15 per cent at room temperature to 70 C, utilizing 0.2 per cent organic inhibitor. Mobile pickling equipment is in service. The inhibitor used most frequently for sulfuric acid has been benzothiazole.

There are many organic inhibitors of corrosion. Those particularly effective in reducing corrosion on steel in sulfuric acid are organic amines, aldehydes and sulfur compounds such as mercaptans and urea derivatives. The com-

(Continued on page 132)

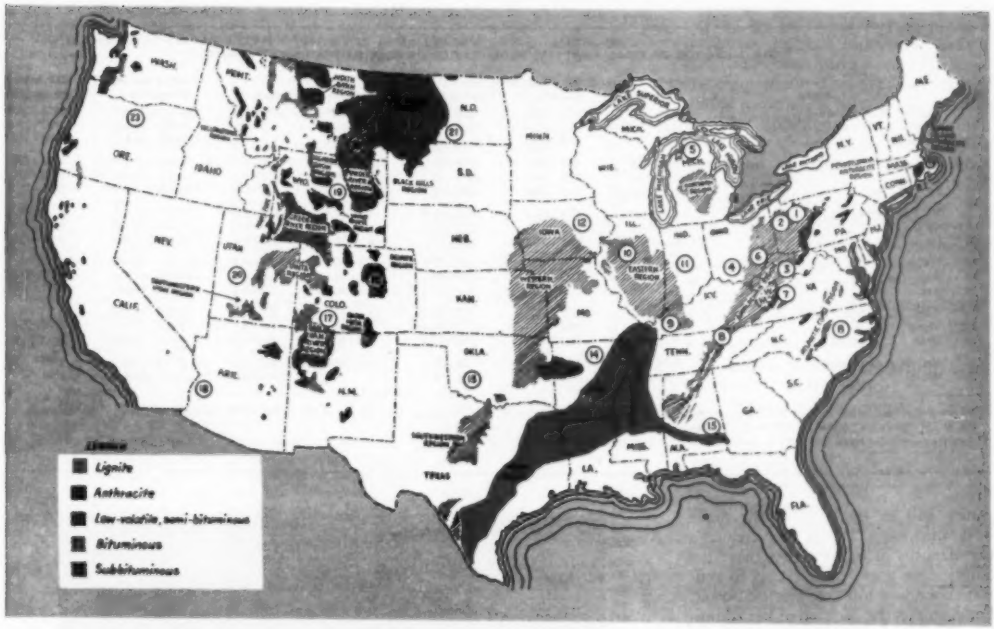


Fig. 1—Major U. S. coal producing districts. Range of coal analysis from each of these districts is listed in Table 1

Design and Operation of Steam Generators for

UTILIZATION OF LIGNITE COALS

WILLIAM J. HARGEST and RALPH A. MOLLER

• To date, the vast deposits of lignite coals in the United States have remained almost unscratched. Recently, however, the following events have occurred that may have a tremendous effect on future demand: (1) Growth of power requirements arising from municipal and industrial expansion. (2) The Missouri Valley system of dams for hydro-electric power and water conservation, instead of reducing demand for fuel and power production, is likely to increase it. (3) Power will be required in the near future for reduction of low-grade iron ores found in the lignite country.

As shown in this article, improvements in steam generating equipment have met the problems of utilizing lignite, and current designs and installations now burn this low-grade coal with peak efficiencies.

I&P Special Report to Industry

VAST DEPOSITS of lignite exist in the United States and in the Canadian provinces of Saskatchewan and Alberta. Known reserves in the United States total 939.5 billion ton, with the largest deposits, estimated at over 900 billion ton, being in the Montana-Dakota region. Locations of lignite deposits in the United States, as well as deposits of other coals, are shown in Fig. 1, while heating values of fuels from different areas in the United States are listed in Table 1.

Real development of firing equipment in central stations and industrial power plants for burning lignite began approximately in 1925 in the United States and about 1915 in Canada. Contributing factors were the westward movement of industry, rapid development of central station power requirements, the rapidly increasing price of competitive fuels, and the changing cost picture of eastern or dock coals in the north central area of the United States and areas of Canada north of Montana and North Dakota.

It has been predicted that increasing numbers of industries and utility com-

TABLE 1—RANGE OF COAL ANALYSES FROM VARIOUS AREAS IN THE UNITED STATES

District No.*	State	Analysis, as fired — Moisture, %	Volatile, %	Fixed carbon, %	Ash, %	Sulfur, %	Heating value, Btu per lb	Ash fusion temp., F
1	Penn'a, W. Va., Md.	1.1 - 4.3	14.2 - 34.4	52.1 - 80.0	8.5 - 14.7	0.5 - 3.4	12,830 - 14,100	2100 - 3000
2	Penn'a.	2.3 - 3.7	24.2 - 38.6	61.6 - 46.9	6.7 - 15.6	1.1 - 3.2	12,030 - 13,710	2100 - 2900
3	W. Va.	2.0 - 3.3	28.8 - 37.8	51.0 - 61.9	2.5 - 15.6	0.7 - 2.5	13,080 - 14,800	2000 - 3000
4	Ohio	3.8 - 12.0	30.1 - 39.6	41.9 - 53.2	6.8 - 14.6	0.4 - 3.7	10,280 - 13,050	2100 - 2700
6	W. Va.	3.5 - 5.9	35.5 - 39.5	48.7 - 50.6	8.3 - 9.8	2.3 - 4.2	12,550 - 13,030	2000 - 2200
7	Va., W. Va.	1.5 - 3.6	11.5 - 34.4	58.0 - 74.7	3.4 - 19.4	0.5 - 1.0	12,000 - 14,890	2100 - 3000
8	W. Va., Tenn., Va., Ky., N. C.	1.9 - 5.2	22.3 - 41.3	44.3 - 67.8	3.3 - 10.4	0.5 - 3.4	12,420 - 14,400	2100 - 3000
9	Ky.	4.5 - 11.6	31.9 - 40.2	41.5 - 53.7	5.6 - 12.8	1.0 - 4.5	10,830 - 12,780	2000 - 2100
10	Ill.	6.5 - 17.0	32.9 - 37.2	38.6 - 51.2	6.8 - 12.4	0.8 - 5.1	10,530 - 12,490	2000 - 2500
11	Ind.	10.9 - 16.0	31.3 - 40.3	39.0 - 47.6	6.2 - 11.1	0.6 - 4.6	11,010 - 12,010	.....
13	Ala., Ga., Tenn.	1.9 - 4.7	20.0 - 38.4	47.7 - 70.5	3.8 - 12.9	0.6 - 1.5	11,620 - 14,410	2100 - 2900
14	Ark.	1.7 - 4.2	11.6 - 17.9	71.3 - 77.3	4.3 - 9.1	0.7 - 3.1	13,700 - 14,640	2300 - 2500
15**	Kan., Mo., Okla., Texas	2.2 - 24.1	17.3 - 46.0	32.3 - 72.7	3.3 - 17.6	0.7 - 5.3	8,090 - 14,550	.....
19**	Wyo.	5.6 - 23.8	29.9 - 37.8	35.2 - 49.8	3.2 - 16.4	0.5 - 4.7	8,660 - 12,650	2100 - 2500
20	Utah	4.1 - 17.9	27.7 - 41.9	36.7 - 51.7	5.4 - 17.7	0.5 - 6.1	8,530 - 13,220	.....
21	No. Dakota (Lignite)	19.4 - 43.0	23.0 - 31.0	20.0 - 41.5	5.0 - 14.0	0.2 - 1.5	6,300 - 9,210	2100 - 2700
23	Wash.	3.6 - 29.3	29.8 - 37.8	30.9 - 50.7	4.5 - 19.5	0.4 - 2.0	7,790 - 12,660	2100 - 2800

*District numbers refer to like numbers on the map shown as Fig. 1. Data in this Table, as well as the map, were made available through the courtesy of the U. S. Bureau of Mines and the U. S. Geological Survey.
**Analyses include those for bituminous, sub-bituminous and lignite coals.

panies will in the next decade move west and south to tap the country's vast deposits of lignite and achieve the long sought goal of cheap fuel to generate abundant low cost electric power. For example, the decision of the Aluminum Company of America to use lignite for its new $80 million smelting plant in Milam County, Texas, which is scheduled to begin production next year, is seen as a major step toward the eventual widespread use of lignite as a power-generating fuel.

Lignite is basically a high inherent moisture coal low in calorific value, and is mined at relatively low cost. It fires rapidly in storage, due to spontaneous combustion, particularly during summer months. A pile formed by a a clamshell, not compacted, will fire in 30 to 60 days. The compaction method in storing lignite is now being used, and the best practice to date is to build up a pile in 1-ft thick layers not exceeding a total height of 6 to 8 ft, and compacting each layer with a bulldozer, sheepfoot packer or roller. There are now a number of lignite storage piles in excess of 5000 ton each that have been in storage from 3 to 5 years.

High moisture content, low calorific value and instability in storage, as well as current freight rates and competitive coal prices, are the major factors which prevent shipment of lignite for distances greater than 200 to 400 miles. Consequently, lignite is today a local area fuel.

By 1930 eastern coals were still in general use in the lignite and subbituminous areas. It was about this time that increased demand for electrical power predicated construction in lignite areas of central stations larger than theretofore erected, and promoted active development of spreader stokers and steam generators specifically designed for firing lignite.

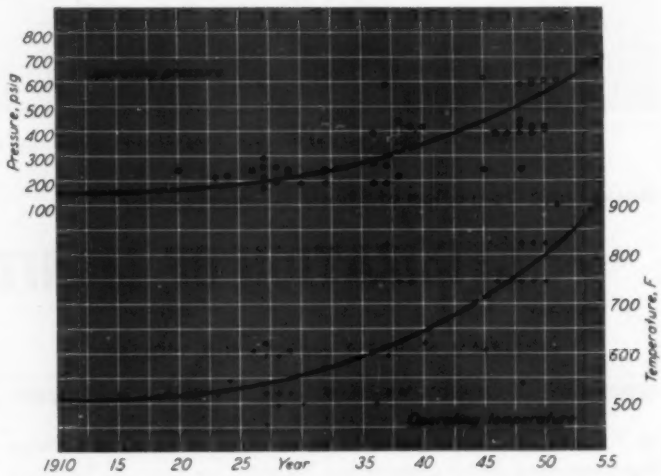


Fig. 2—Boiler pressures and steam temperatures started upward trend about 1930 when increased demand for electrical power promoted development of the spreader stoker and steam generators specifically designed for firing low-grade lignite coals

Inasmuch as the greatest utilization of lignite in central stations and industrial plants has been in the Montana-Dakota region, members of INDUSTRY AND POWER's editorial staff covered the area on a 4000 mile trip to obtain information and data on current practices in firing lignite. Cooperation in this project was sought and obtained from officials at the U. S. Bureau of Mines Lignite Laboratory at Grand Forks, North Dakota. Data obtained were correlated and are, for the most part, presented in Tables in this article.

Table 2 lists locations of plants where such data and information were obtained; also, it lists all the boilers in active service at the plants as well as their approximate ages, capacities, pressures, and temperatures. The boilers range from one having a pressure of 165 psi to the new boilers at the Minnkota plant that operate at 865 psi. Table 3 lists analyses of fuels burned at a number of the power stations visited. Fig. 2 shows graphically the upward trend in both temperatures and pressures in steam generators firing lignite.

This article places emphasis upon direct utilization of lignite without pre-

TABLE 2—COMPARISON OF STEAM GENERATORS INSTALLED FOR FIRING LIGNITE IN MONTANA-DAKOTA REGION

No. boilers alike	Age	Plant	Name of company	Steam cap., lb per hr	Pressure, psi	Temperature, F
2	1951	William Neal (1)*	Central Power Cooperative	230,000	865	905
	1951	Minnkota (2)	Minnkota Cooperative Power Co.	135,000	615	825
	1950	Ortonville, Minn.	Otter Tail Power Co.	160,000	865	900
	1950	Grand Forks, N. D.	Northern States Power Co.	75,000	425	750
	1950	Minnkota (2)	Minnkota Cooperative Power Co.	72,000	615	825
	1950	Valley City, N. D.	Municipal Utility	50,000	425	750
2	1950	Mobridge, S. D.	Montana-Dakota Utilities Co.	50,000	415	750
	1949	Kidder (3)	Otter Tail Power Co.	100,000	600	825
	1949	Devils Lake, N. D.	Otter Tail Power Co.	100,000	600	750
	1949	Fargo, N. D.	Northern States Power Co.	75,000	425	750
	1949	Bison (4)	Northern States Power Co.	75,000	420	750
	1949	Crookston, Minn.	Otter Tail Power Co.	75,000	400	825
	1949	Minnkota (2)	Minnkota Cooperative Power Co.	72,000	615	825
2	1949	Beulah, N. D.	Montana-Dakota Utilities Co.	50,000	400	750
	1949	Moorhead, Minn.	Public Service Department	45,000	400	750
	1948	Jamestown, N. D.	Otter Tail Power Co.	100,000	600	825
	1948	Hoot Lake (5)	Otter Tail Power Co.	95,000	400	825
	1948	Grand Forks, N. D.	Northern States Power Co.	75,000	425	750
	1948	Crookston, Minn.	Otter Tail Power Co.	75,000	400	825
	1948	Bismark, N. D.	Montana-Dakota Utilities Co.	60,000	450	750
	1948	Kincaid, N. D.	Montana-Dakota Utilities Co.	60,000	250	545
	1947	Devils Lake, N. D.	Otter Tail Power Co.	75,000	400	750
	1946	Moorhead, Minn.	Public Service Department	45,000	400	750
2	1945	Aberdeen, S. D.	Northwestern Public Service Co.	45,000	625	850
	1945	Washburn, N. D.	Otter Tail Power Co.	40,000	250	610
2	1940	Valley City, N. D.	Municipal Utility	40,000	425	625
	1939	Fargo, N. D.	Northern States Power Co.	100,000	425	750
	1938	Fargo, N. D.	Northern States Power Co.	50,000	225	525
2	1938	Bismark, N. D.	Montana-Dakota Utilities Co.	30,000	450	750
	1937	Kidder (3)	Otter Tail Power Co.	100,000	600	825
	1937	Grand Forks, N. D.	Northern States Power Co.	65,000	200	525
	1937	Beulah, N. D.	Montana-Dakota Utilities Co.	50,000	265	600
	1936	Minot, N. D.	Northern States Power Co.	54,000	200	505
	1936	Valley City, N. D.	Municipal Utility	35,000	275	500
	1936	Moorhead, Minn.	Public Service Department	17,500	400	750
2	1932	Grand Forks, N. D.	Northern States Power Co.	45,000	200	525
2	1932	Kincaid, N. D.	Montana-Dakota Utilities Co.	25,000	250	530
	1930	Minot, N. D.	Northern States Power Co.	32,000	200	505
	1929	Fargo, N. D.	Northern States Power Co.	110,000	225	525
	1929	Washburn, N. D.	Otter Tail Power Co.	40,000	250	610
2	1929	Harvey, N. D.	Otter Tail Power Co.	23,000	230	610
	1928	Beulah, N. D.	Montana-Dakota Utilities Co.	50,000	285	600
	1928	Grand Forks, N. D.	Northern States Power Co.	45,000	200	523
2	1928	Jamestown, N. D.	Otter Tail Power Co.	30,000	200	500
	1927	Fargo, N. D.	Northern States Power Co.	110,000	225	525
2	1927	Kidder (3)	Otter Tail Power Co.	70,000	300	625
	1927	Beulah, N. D.	Montana-Dakota Utilities Co.	50,000	265	600
	1927	Bismark, N. D.	Montana-Dakota Utilities Co.	40,000	180	440
2	1926	Washburn, N. D.	Otter Tail Power Co.	40,000	250	610
	1924	Harvey, N. D.	Otter Tail Power Co.	45,000	230	550**
	1923	Fargo, N. D.	Northern States Power Co.	32,000	225	525
	1920	Aberdeen, S. D.	Northwestern Public Service Co.	60,000	250	600
	1920	Aberdeen, S. D.	Northwestern Public Service Co.	35,000	250	600
2	1915	Minot, N. D.	Northern States Power Co.	20,000	165	525
2	1910	Minot, N. D.	Northern States Power Co.	20,000	165	525

*NOTES: (1) Voltaire, N. D. (2) Grand Forks, N. D. (3) Wahpeton, N. D. (4) Minot, N. D. (5) Fergus Falls, Minn.

**Rebuilt since initial installation.

preparation, separate moisture reduction, or other methods of beneficiation. High and low temperature distillation, carbonization and gasification are subjects not included here. In general, engineers are convinced that direct utilization without pre-preparation represents the basic method whereby a so-called "low grade fuel" can be rendered available at the least overall cost in terms of fuel cost per kilowatt hour.

Firing Methods

Three different methods of burning lignite are in general use. They are listed below together with a statement of the type of heat recovery equipment used:

1. *Spreader stokers* with (*A*) economizer and air heater in series or (*B*) air preheaters only.

2. *Forced draft zoned traveling grate stokers* with (*A*) economizer and air preheater in series or (*B*) air preheaters only.

3. *Unit-type pulverizers* utilizing primary and secondary air preheaters, with high primary air temperature admitted to mills and secondary lower preheated air temperatures admitted to burner plenum boxes.

The preferred firing method of the central station and industrial plant is the spreader stoker, using preheated air and the continuous ash discharge traveling grate. This type of grate is preferred on all sizes of boilers rather than the dump grate type on account of the cleanliness factor in the boiler room and the elimination of smoke, dust and dirt.

Cyclone Furnace — Recently, tests with North Dakota lignite were conducted at the Calumet Station of the Commonwealth Edison Co. of Chicago where this lignite was fired in the horizontal cyclone furnace installations at that station. The test results can be summarized as follows:

1. Lignite can be successfully burned in the cyclone furnace.

2. Primary air temperature of around 650 F is required to provide the necessary drying to give good ignition.

3. Slag behavior is similar to Illinois Kincaid coal, although it may be a little more viscous.

4. The crushing characteristics are somewhat different than for other coals burned, the crushed product being coarser and more flaky.

5. There is no smoke discharge from the stack regardless of excess air.

6. To eliminate the need for predrying equipment, a cyclone furnace fired unit designed for burning lignite should be arranged for direct firing to permit drying in the crusher.

7. Although dust loading tests were not conclusive, indications were that ash discharge from the stack was somewhat lower than when burning Illinois Kincaid coal.

There were a few attempts to adapt existing underfeed stoker installations from eastern coal to lignite. These were generally unsuccessful due to lignite being a non-coking fuel and due to the fact that the mechanical operation of this stoker tended to crush the lignite to a powder and made burning extremely difficult. However, one plant used a mixture of 50 per cent eastern and 50 per cent lignite for some years with fair success.

At present the largest stoker fired installation in the lignite area is a 160 thousand lb per hr continuous rating unit. Because of the large furnace volumes and the great areas which are required, maximum size stoker unit in the thinking today seems to be 250,000 lb of steam per hr. For capacities over 250,000 lb per hr, boilers will probably be fired by pulverized lignite or some other type of equipment.

Table 4 gives a comparison of firing rates, boiler, furnace, and grate efficiencies, and heat release of boilers using different types of firing equipment. The average is the most significant. The average for the traveling grate

TABLE 3—TYPICAL ANALYSES OF LIGNITE FIRED IN MONTANA-DAKOTA REGION POWER PLANTS

Plant	Size, in.	Analysis, as fired: Moisture, %	Volatile, %	Fixed carbon, %	Ash, %	Sulfur, %	Heating value, Btu per lb	Ash fusion temp., F
Bismarck	1.00 (S)*	34.0	28.0	32.0	—	0.7	7071	3150
Beulah	2.00 (S)	36.0	27.0	28.0	—	0.7	6700	2025
Aberdeen	1.25	35.5	27.2	30.5	6.8	0.8	7200	2205
Aberdeen	0.75	19.4	26.9	41.5	12.2	1.2	9210	2365
Ortonville	0.75	43.0	31.0	20.0	6.0	0.8	6170	2100
Kidder	1.00 (C)*	39.0	24.0	30.0	6.0	0.6	6650	—
Hoot Lake	0.75	35.0	30.0	30.0	5.0	0.6	7000	2340
Moorhead	1.50 (C)	35.0	26.0	32.0	—	0.6	7000	2200
Fargo	0.75	33.0	23.0	29.0	14.0	0.2	7000	2200
Crookston	2.00	37.0	25.0	32.0	6.0	—	6900	—
Grand Forks	1.50 (C)	36.0	—	—	5.0	—	7045	—
Minnkota	1.50 - 2.00 (C)	37.0	26.0	33.0	7.0	—	7000	—
Devils Lake	1.00	39.0	27.0	27.0	7.0	1.5	6300	2100
Jamestown	2.00	38.0	30.0	24.0	7.0	1.2	6610	2200
Valley City	1.50	39.0	27.0	28.0	7.0	1.0	6626	—
Harvey	0.50	39.0	28.0	27.0	7.0	0.4	6617	—
William Neal	Pulverized	39.0	25.4	29.0	6.6	0.4	6600	2200

*Abbreviations: S — screenings. C — crushed.

Average ultimate analysis of typical Dakota lignite, as fired: Hydrogen, 7.28%; carbon, 35.79%; nitrogen, 0.66%; oxygen, 47.19%; sulfur, 0.43%; ash, 8.66%; heating value, 6578 Btu per lb; ash fusion temperature, 2100 F.

stoker is 27,029 Btu per cu ft per hr. The average for the spreader stoker is 35,000 Btu per cu ft per hr, and for the pulverizers it is 20,767. Even after allowing for the limited number of cases and perhaps some inaccurate data in one or two instances, it is readily seen that there is a distinct break between the heat release rates of the various types of firing equipment.

Pulverizers are in use in the Crookston plant and are to be installed in the new Voltaire plant of the Central Electric Power Cooperative. Pulverizers are believed to be practical only in plants larger than 10,000 kw or on boilers larger than 120,000 lb of steam an hr, except in special cases. Some managers doubted if the advantages of a pulverizer below that size paid for the increased power required to operate the pulverizing mills. The trend seems to be toward the use of pulverizers for the largest units.

Table 5 presents a summary of Table 4 and a comparison of recent boilers with the same temperature, pressure, and capacity range of those burning bituminous coal. It will be noted that the performance of lignite burning boilers is the same as that of bituminous burning boilers, with the natural exception of pounds of coal per square foot of grate area. The consumption of lignite expressed in this ratio is larger because of a lower Btu content. However, it should be noted that the heat release data, which is more significant, is nearly identical.

Furnace Construction

The older boilers listed in Table 2 are constructed with refractory walls, or in some cases with a back or front water-wall. On the other hand the new boilers are almost entirely of bent tube construction with a water-wall all around the furnace. An exception is the boiler at the Bison plant which has water-walls on only three sides.

Formerly boilers had three or more passes. The newer boilers are either straight through or only have two passes. When lignite is burned it produces a long flame. Therefore, the furnace is higher or taller than when other fuels are burned. Consequently, the furnace volume is also larger. Boilers

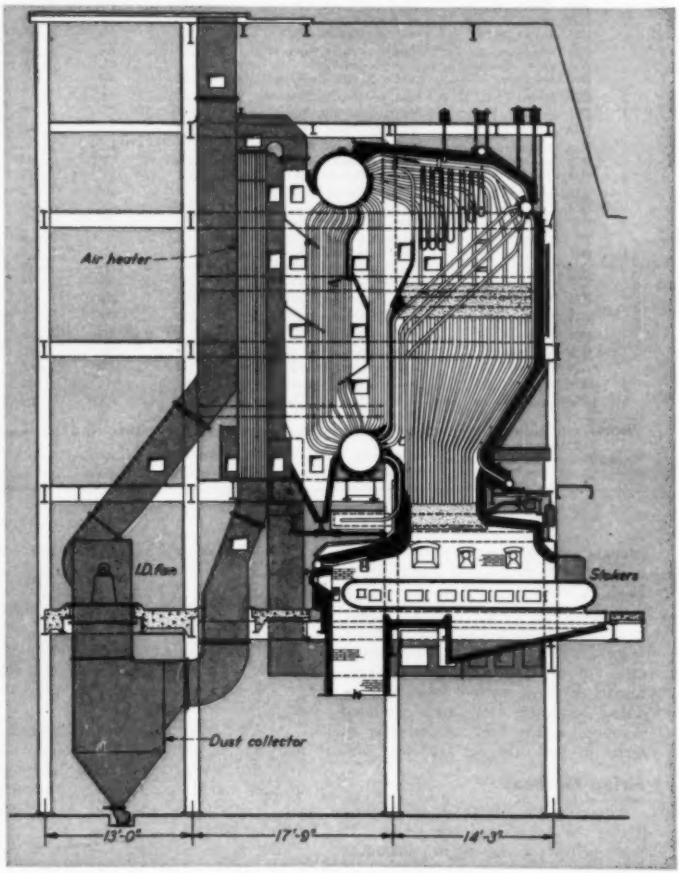


Fig. 3—Boiler of 75,000 lb per hr capacity at Devils Lake, N. D. Station has two traveling grate stokers. Unit consists of superheater, water-cooled furnace, steel clad setting, and air heater. Combustion air is preheated to temperatures between 400 F and 450 F

TABLE 4 — BOILER, FURNACE AND STOKER DATA FOR TYPICAL STEAM GENERATORS FIRING LIGNITE

Boilers and Auxiliary Equipment:

Plant	Year new	Capacity, lb per hr	No. of drums	Heating surfaces, sq ft: Boiler	W.W.	S.H.	Econ.	A.H.	Pressure, psi	Temperature, F	Superheat, F	Chamber construction
Beulah	1949	50,000	2	4628	1015	....	None	....	400	750	302	Water walls
Bismarck	1948	60,000	2	7700	....	900	None	8000	450	750	293	Refract. walls
Kincaid	1948	60,000	2	8999	1051	....	None	....	250	541	139	Water walls
Mobridge	1950	50,000	2	4628	1015	....	None	....	415	718	298	Water walls
Minot	1949	75,000	4	8150	1168	....	None	5000	420	718	297	W. W. except front
Fargo	1939	110,000	1	11510	....	....	None	....	225	525	128	Refract. walls
Grand Forks	1950	75,000	4	8350	....	1730	None	5800	425	750	296	Water walls
Crookston	1948	75,000	2	7555	3400	1630	None	11600	400	825	377	Water walls
Crookston	1949	75,000	2	9250	2025	....	None	6300	400	825	377	Water walls
Devils Lake	1948	100,000	2	10435	2460	....	None	9450	400	750	302	Water walls
Hoot Lake	1948	95,000	2	10170	2436	....	None	1850	4330	400	825	377	Water walls
Jamestown	1948	100,000	2	12670	2195	....	None	....	600	825	337	Water walls
Kidder	1949	100,000	4	9500	2200	....	2400	13000	600	825	337	Water walls
Ortonville	1950	160,000	2	16250	4230	4780	6100	17200	865	900	371	Water walls
Aberdeen	1945	45,000	1	4720	870	....	1430	4700	625	850	357	Partial W. W
Minnkota	1950	135,000	2	14950	1825	5370	4620	16890	615	825	335	Water walls
Wm. Neal	1951	230,000	2	13610	9615	6600	None	....	865	905	376	Water walls
Moorhead	1949	45,000	4	6270	1045	....	None	7250	400	750	302	W. W. 3 sides

Furnace, Stoker and Grate Specifications:

Plant	Furnace vol., cu ft	Grate area, sq ft	Lb of lignite per hr	Heat release (based on 6600 Btu per lb of lignite): Btu per cu ft per hr	Btu per sq ft per hr	Based on lb steam per hr	Type of stoker	Grate and direction of travel: Grate	Direction	Type of ash disposal
Beulah	2683	125	17,500	30,800	658,000	50,000	Spreader	Traveling	To front	Pneumatic
Bismarck	2550	212	14,550	37,600	453,000	60,000	Chain grate	Traveling	To rear	Pneumatic
Kincaid	3250	163	13,500	27,400	546,000	60,000	Spreader	Traveling	To front	Pneumatic
Mobridge	2683	125	12,500	30,800	658,000	50,000	Spreader	Traveling	To front	Pneumatic
Minot	4195	238	16,800	26,400	483,000	75,000	Spreader	Traveling	To front	Hydraulic
Fargo	....	284	19,900	....	463,000	....	Spreader	Dump	....	Pneumatic
Grand Forks	4195	230	17,000	26,700	487,000	75,000	Spreader	Traveling	To front	Pneumatic
Crookston	5430	None	18,300	21,300	....	75,000	(Pulverized coal fired)			Pneumatic
Crookston	4800	195	16,800	22,700	560,000	75,000	Spreader	Traveling	To front	Pneumatic
Devils Lake	7660	304	22,400	19,300	487,000	100,000	Spreader	Traveling	To rear	Pneumatic
Hoot Lake	6500	253	21,000	21,000	540,000	95,000	Spreader	Traveling	To front	Pneumatic
Jamestown	6150	288	22,200	23,500	502,000	100,000	Spreader	Traveling	To front	Pneumatic
Kidder	4100	316	22,100	34,200	442,000	100,000	Chain grate	Traveling	To rear	Hydraulic
Ortonville	12250	446	37,200	19,600	452,000	160,000	Spreader	Traveling	To front	Pneumatic
Aberdeen	1700	156	8,600	30,400	364,000	....	Chain Grate	Traveling	.....	Pneumatic
Minnkota	7750	392	15,300	12,800	252,000	75,000	Spreader	Traveling	To front	Pneumatic
Wm. Neal	17200	None	46,200	17,700	.....	225,000	(Pulverized coal fired)			Pneumatic
Moorhead	3000	145	10,700	23,500	487,000	42,000	Spreader	Traveling	To front	Pneumatic

Firing Rates, Heat Releases and Efficiencies on Test Runs:

Plant	Maximum cont. capacity, lb per hr	Lignite firing data: lb per hr	Btu per lb	Bed thick., in.	Ton per day	Heat release: Btu per cu ft per hr	Btu per sq ft per hr	Temperatures, F: Primary air	Secondary air	Boiler exit	Stack	Effic-iency, %
Beulah	50,000	12,500	6700	10	....	31,100	670,000	400	400	640	550	79
Bismarck	60,000	14,550	6500	12	180	37,000	446,000	420	420	660	405	78
Kincaid	60,000	13,500	6643	12	185	27,500	550,000	450	Room	680	460	77
Mobridge	50,000	12,500	6700	....	200	31,100	670,000	425	425	750	630	79
Grand Forks	75,000	17,000	6576	....	....	26,700	487,000	350	350	685	465	78
Crookston	75,000	16,800	6916	....	....	23,200	596,000	350	Room	780	480	76
Crookston	75,000	18,300	6916	....	170	23,300	(At pulverizer	700)	375	775	485	76
Devils Lake	100,000	22,400	6500	16	270	19,000	480,000	375	375	605	385	75
Hoot Lake	95,000	21,000	7090	....	145	22,900	587,000	375	375	600	380	74
Jamestown	100,000	22,200	6610	6	180	23,900	510,000	350	Room	675	—	77
Kidder	100,000	22,100	6650	12	....	35,900	455,000	360	360	600	360	79
Ortonville	160,000	37,200	6170	....	300	18,700	515,000	370	370	590	355	79
Aberdeen	45,000	8,600	7194	11	200	36,400	396,000	390	390	640	410	78
Minnkota	72,000	15,300	7000	....	300	26,600	625,000	360	Room	—	370	78
Moorhead	45,000	11,500	7000	....	110	26,700	554,000	321	—	561	486	80

NOTE: Plants are listed in the same order in each section of this Table. Data in each section are for the same boiler at each plant.
Abbreviations: W.W. — water wall; S.H. — superheater; Econ. — economizer; A.H. — air heater; Refract. — refractory.

which are built too short have difficulty in getting the most heat out of lignite at heavier loads.

Most installations have been designed on the basis of the return of the separated solids from the flue gas to the furnace. Performance data are usually computed on the basis of 85 per cent recovery of the solids leaving the steam generator.

For the high inherent moisture lignite fuels, temperatures to the grate have been increasing and now 400 F is considered present top limit.

The preferred type of furnace is of

TABLE 5—COMPARATIVE DATA FOR PLANTS BURNING LIGNITE AND BITUMINOUS COAL

Fuel and firing equipment	No. of boilers	Heat release: Btu per cu ft per hr	Btu per sq ft per hr	Firing rate, lb per sq ft grate	Capacity, lb of steam per hr
Plants Burning Lignite:*					
A. Traveling grates	6	35,100	414,833	62.1	56,700
B. Spreader stokers 21		27,029	562,333	76.9	73,000
C. Pulverizers	3	20,767	—	—	—
Plants Burning Bituminous Coal:**					
A. Traveling grates	2	35,956	450,000	35.9	85,000
B. Spreader stokers 25		26,248	465,000	36.5	63,000
C. Pulverizers 29		21,048	—	—	—
D. Underfeed stokers	9	28,022	489,000	36.6	70,000

*Compiled from data in Table 4 of this article.
**Data from "New Steam Generators in Pulp and Paper Industry," by J. S. Toby, "Utilization," No. 12, 1948, p. 17.

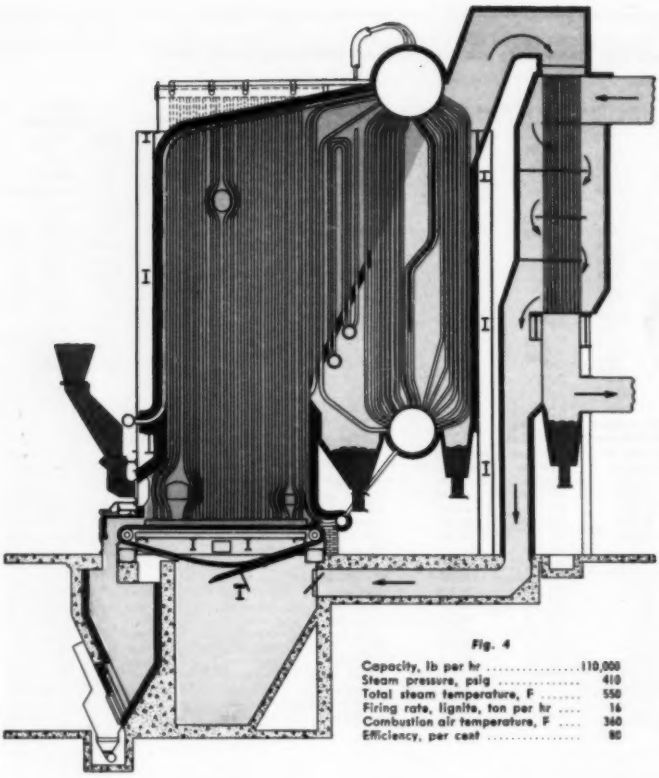


Fig. 4

Capacity, lb per hr	110,000
Steam pressure, psig	410
Total steam temperature, F	550
Firing rate, lignite, ton per hr	16
Combustion air temperature, F	360
Efficiency, per cent	80

Fig. 4—Two Sterling-type two-drum bent-tube boilers of the design shown here were installed recently at the Moorhead, N. D. beet sugar factory of the American Crystal Sugar Co. Latest design features for firing lignite coals are used

the high rectangular type, with black surface amounting to approximately 30 to 35 per cent of the total, with a minimum of 25 per cent. No ignition arches are required or desirable in the furnace arrangement. Furnace heat liberation of 30,000 to 35,000 Btu per cu ft of furnace volume is usually recommended by steam generator builders.

With early installations, the long flame and the large quantity of low fusion temperature fly ash resulted in rapid plugging of boiler passes. To cope with this condition, furnace heights were increased in order to give more complete burning of these gases and reduce the temperature of the fly ash. Effective slag screens were, of course, necessary and the use of water-wall surface was also necessary to reduce furnace temperatures, although the use of water-walls was approached with caution so as not to reduce the furnace temperatures below that required for proper combustion with this high moisture fuel. Due to the large quantity of fuel burned in suspension, the heat release at the grate is proportionally low. Furthermore, the evaporation of the moisture not released before the fuel reaches the grate tends to reduce the temperature at the grate. Therefore, although dealing with a low fusion ash fuel, preheated air can be utilized to advantage to accelerate combustion and reduce the length of the flame without abnormal clinkering problems.

Due to the high inherent moisture

Fig. 5—Traveling Grate Stoker: Performance records of steam generators at Devils Lake and Kidder Stations. See Fig. 3 for design of steam generator installed at Devils Lake

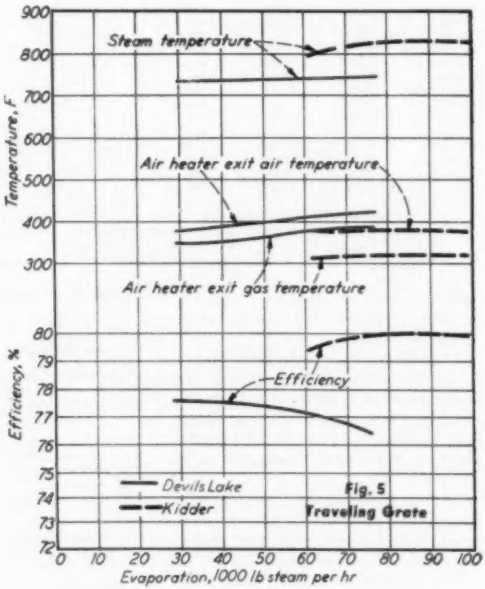


Fig. 5
Traveling Grate

Fig. 6—Spreader Stoker: Similar spreader stokers for firing lignite were installed under new steam generators in 1949 at the Minnkota and Crookston Stations. Performance records of both are shown in this graph. The Minnkota boiler, which is shown in Fig. 8, includes modern design features

Fig. 7—Unit Pulverizer: This graphic performance record is for the pulverized lignite fired boiler shown in Fig. 9. Located at the Crookston Station, it has operated exclusively on lignite since it was installed in 1948. Few of these units are used today for lignite, but installations are expected to increase when capacities above 250,000 lb per hr are needed

content of lignite coal, there is released in the furnace a large amount of highly superheated steam, along with the gases of combustion. This results in an unusually high mass flow of gas through the superheater of the boiler, as well as the convection section, air preheater and economizer if used. Due to this high mass flow across the superheater, superheaters designed on the ordinary basis in general seriously overshoot the predicted temperatures; therefore, less superheat surface is required than normally used for so-called eastern coals.

Attempts to establish feasible designs of "open-type" furnaces in connection with North Dakota lignite have invariably resulted in the necessity for expensive modifications. It may be noted, in passing, that the "anthracite type" installation commonly used in connection with the burning of anthracite has not proved to be suitable for handling North Dakota and other lignite.

When arches are used it is not done to improve ignition effect of the hot surface so provided, but rather to mix effectively rich gases from the front end of the furnace with lean gases from the rear end of the furnace. Contrary to expectations, the implementation of overfire air as a complete substitute for deflecting surfaces has proved in many instances unsatisfactory. This conclusion should not be interpreted as justifying the assumption that overfire air is not helpful. Information on current practice in connection with overfire air application follows:

Overfire Air

Overfire air has been used to an increasing degree as a supplementary device for improving the efficiency of mixing the extremely long flame lignites. The larger proportion of installations has utilized secondary blowers at static air pressures between 20 and 25 in. of water, and with total deliveries up to approximately 10 to 15 per cent of the total air required for combustion. The effect of overfire air injection must be considered as supplementary to rather than as a substitute for a type of furnace design which will in itself allow necessary mixing action to provide required oxygen for complete combustion of carbon particles and hydro-carbon gases at the various elevations in the furnace. Within limits of this understanding it is said that use of overfire air in furnaces of this type is beneficial.

Radiant Air Preheater

An interesting development, the details of which have not previously been made generally available and the potentialities of which have not yet been completely gaged, is represented by the so-called radiant air preheater. This holds forth satisfactory promise for further improvements in the combustion process, particularly as it applies to the handling of high moisture fuels.

The radiant air preheater is essentially a section of air preheater surface composed of tubes exposed within the furnace limits and located approximately in positions comparable to those ordinarily applying to front water-walls. The air passes through the tubes and the radiant air preheater absorbs heat by radiation from the flame.

Secondary air is applied through the medium of a positive pressure blower which is capable of delivering approximately 15 per cent of the total air for combustion at a static pressure of approximately 20 in. of water. The radiant air preheater tubes, alternating with the water-wall tubes, are spaced on approximately 6¾ in. centers. The arrangement of interconnecting piping between the inlet and outlet header has been devised to permit the temperature of the air delivered from the radiant air preheater to be controlled at a specified value by adjusting the respective groups of dampers indicated, thus varying the amount of air passing through the radiant air preheater tubes as compared to that which is discharged to the outlet header.

This device has just been developed by L. Pistner of the Fuel Economy Engineering Co. in an attempt to establish a means for securing higher preheated air temperatures than those which would normally be secured in connection with convection type air preheaters. It had been evident for some time past that while temperatures of 450 F represent the maximum which

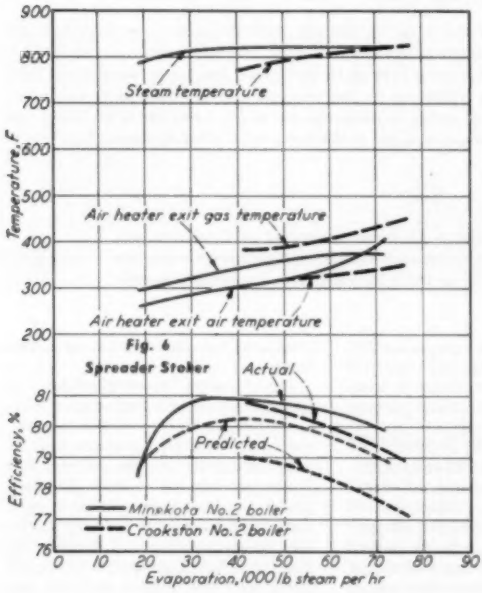
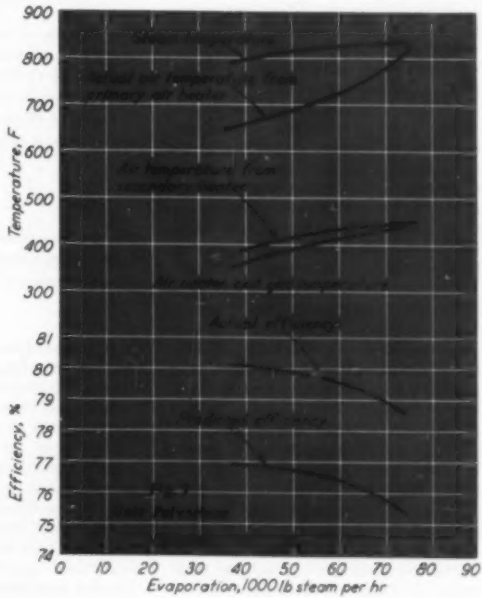


Fig. 6 Spreader Stoker



can probably be tolerated by a stoker grate surface, no such limit applies when preheated air is applied to a furnace either through the medium of overfire injection or as a means of rapidly pre-drying the fuel entering the furnace. It was contemplated that when burning lignites of extremely high moisture content, higher preheated air temperatures than those securable with convection air preheaters would be of material benefit. In actual practice, temperatures up to 1000 F have been attained and higher temperatures are possible in connection with the radiant air preheater.

Traveling Grate Stokers

The behavior of lignite on traveling grate stokers is entirely different from that of bituminous coals. The fuel burns down from the surface and the charring of the lignite at the surface of the fuel bed is readily observable. Fuel bed thicknesses of the order of 15 to 18 in. are maintained up to a point beyond the second zone of the stoker, at which point the moisture in the fuel has been evaporated to an indeterminate extent. The fuel bed thickness then collapses rapidly; this entire phenomenon occurs in a longitudinal distance of approximately 12 to 18 in.

During this short length of travel, the fuel bed thickness is reduced to approximately 2 in. Residual carbon particles and ash only are left on the grate and a heavy mass of flame is generated as a comparatively thin band of volatile gases passing up from the front end of the furnace is intersected by excess air from the rear end of the furnace. There is no uniform combustion rate in the ordinary sense of the term.

Only a small section of the length of the grate is effectively utilized for the burning process and undoubtedly the rate of combustion on that section of the grate is of the order of approximately 300 to 400 lb of lignite per sq ft of grate surface per hr, this zone being preceded by a preliminary ignition, evaporation and preparation zone. The active section of the grate is then followed by a section of the stoker in which the ash is formed.

Because of these rather unusual burning characteristics, the conventional practice of referring to a coal burning rate per square foot of grate surface per hour is actually inapplicable and each section of the grate surface must be independently analyzed from the standpoint of the function which it performs. The average coal burning rate provides an overall picture only.

Limitations in connection with the use of the forced draft traveling grate stoker in terms of latest practices is largely related to sizing preparation of the lignite. Improper and incorrect sizing and preparation result in nonuniform fuel beds with consequent noncontrollability of fuel-air ratio to various parts of the grate surface. This becomes particularly difficult when large quantities of fine fuel are mixed with comparatively small quantities of coarse coal. These limitations are conventional with respect to the forced draft traveling grate stoker and can be obviated by suitable preparation and by installation of proper crushing equipment.

Fig. 3 shows an installation of a forced draft zoned traveling grate stoker equipped with front and rear waterwalls and with air preheaters for air temperatures of between 400 and 450 F. In general, forced draft traveling grate installations are zoned in such a manner as to provide the proper relation between zoning and furnace design. Benefits of preheated air are derived, with this method of firing, not

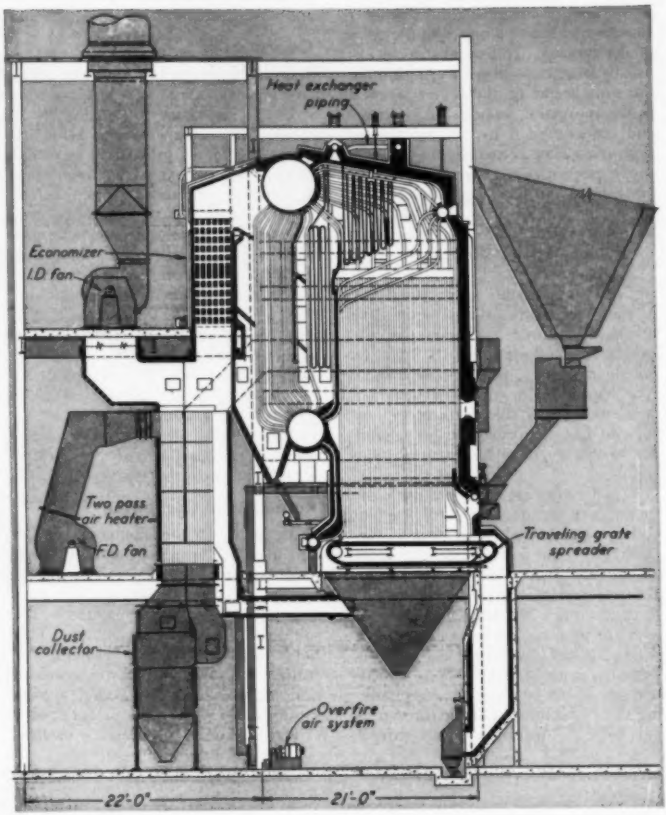
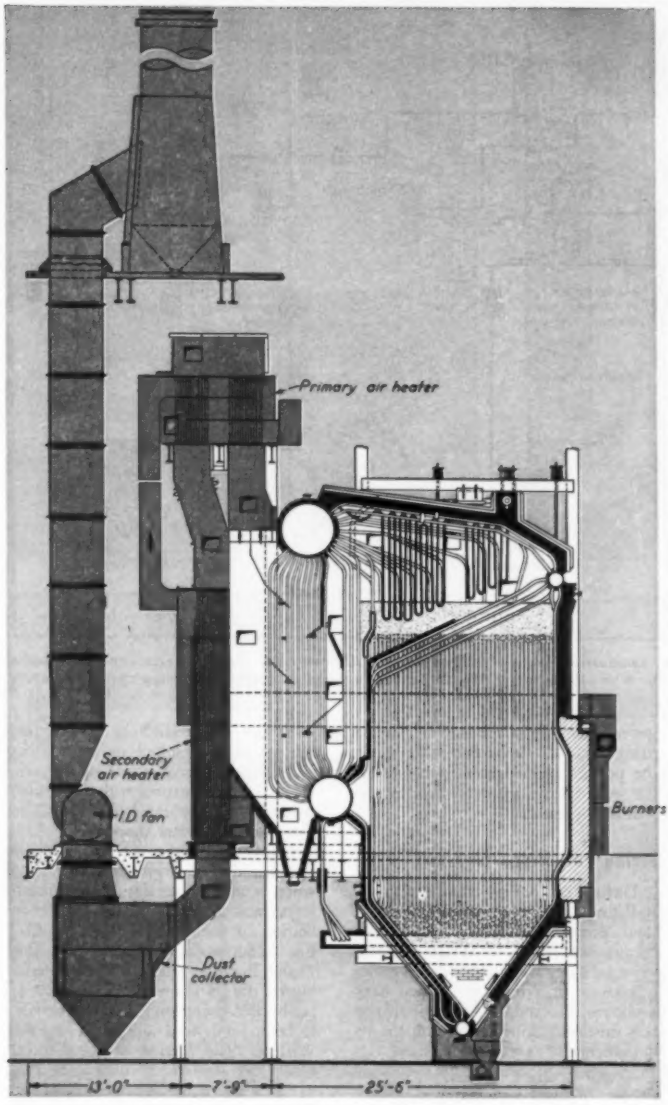


Fig. 8—One of two 72,000 lb per hr, 700 psi, 825 F TT steam generators installed in 1949 at Minkota Station in Grand Forks, N. D. Heating surfaces are as follows: Boiler 7625 sq ft; water-walls, 1805 sq ft; air heater, 8560 sq ft; economizer, 2090 sq ft. Furnace volume is 4000 cu ft. Performance data for these units are shown in Fig. 6. A third unit of similar cross-section but nearly twice the width of the one shown here was recently completed at Minkota and is yielding comparable results

Fig. 9—Pulverized lignite fired steam generator at Crookston was built in 1949 and is one of few such units firing lignite exclusively. Air for combustion is raised to 700 F by primary and secondary heaters



only from the heat recovery obtained, but also from improved ignition with extremely high moisture fuels.

With increasing sizes and operating pressures and temperatures, modifications of earlier arrangements of furnace design and composition of steam generating units became necessary. Typical of somewhat later practice is the boiler at the Wahpeton Station of the Otter Tail Power Co. This unit, designed for a pressure of 650 psig and a steam temperature of 850 F, includes both economizer and air preheater. Fig. 5 is a typical graphic record showing actual performance of boilers with traveling grate stokers.

Spreader Stokers

The spreader stoker is today the preferred method of firing lignite. Current practice is to combine the spreader method of injecting the fuel into the furnace with the use of a zoned forced draft return traveling grate in a completely open archless furnace utilizing full water-wall surfaces throughout the furnace.

Two Stirling-type two-drum bent-tube steam generators, shown in Fig. 4, with superheaters and air heaters, and fired with spreader stokers, were recently installed at the Moorhead, N. D. plant of the American Crystal Sugar Co. Each unit has a maximum rating of 110,000 lb of steam per hr at 410 psi and 550 F total temperature. Stokers fire lignite at the rate of 16 ton per hr. Equipment is designed to operate at 360 F maximum air temperature for combustion.

Fig. 8 shows another typical installation of a traveling grate spreader stoker. The boiler has a capacity of 72,000 lb of steam per hr at 650 psig, 825 F TT and is equipped with economizer and air preheater. Two of these units, installed at the plant of the Minnkota Power Cooperative, Inc., at Grand Forks, N. D. have been in operation for approximately two years. A third unit of similar cross-section but of approximately twice the width indicated for the first two units has recently been completed and is yielding comparable results. Principal operating data, shown on Fig. 6, are of interest because they include information over a large range of ratings from a minimum of 20,000 lb of steam per hr to a maximum of 75,000 lb of steam per hr. Uniformity of the operating results is significant, particularly from the point of view of maintaining good overall efficiencies over this extremely wide range of capacities. This installation utilizes a maximum preheated air temperature of 405 F. There is every indication, again, that the difference between mediocre and optimum operation is a direct function of the ability to maintain preheated air temperatures at this level.

A similar installation at the Crookston Station of the Otter Tail Power Co. has a capacity of 60,000 lb per hr continuously, 75,000 lb per hr maximum, and operates at 450 psig and 750 F TT. In this case, due to lower operating pressure, an air preheater only is used. General operating results and performance are indicated on Fig 6. Preheated air temperature of 450 F. is employed.

The spreader stoker operation in connection with North Dakota lignite has revealed certain idiosyncracies of performance to which attention might well be directed. Basically, while relatively high furnaces are used, the actual zone of intense heat liberation and actively burning gases is encountered to an elevation of approximately 12 ft above the grate surface. Accordingly, the furnaces are subjected to extremely high rates of radiant heat absorption within the limits of the enclosing water-

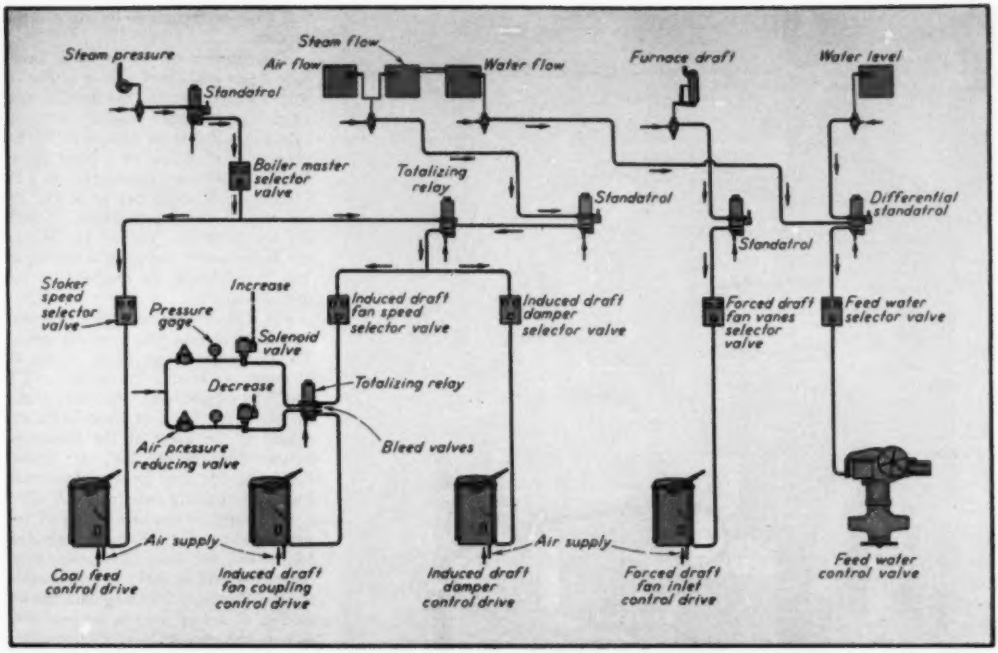


Fig. 10—Diagrammatically shown here is the combustion and feedwater control system at the Ortonville, Minn. Station of the Otter Tail Power Co. Such systems contribute much to the success and dollar economy of firing the lignite coals

wall surface. Above this level, radiant heat absorption to such water-wall surfaces is relatively low, since the subtended angle and the relation of the mass of radiant energy emitting flame in respect to the water-wall surfaces are relatively unfavorable. Despite the radical implication of such a suggestion, it may well be considered pertinent to indicate that in certain cases a lengthening of the flame mass may actually be desirable in order that the heat absorption may be more uniformly distributed over the entire water-wall surfaces.

With the spreader stoker the lignite is introduced into the highly heated furnace zone where there is a flash explosion of the fuel due probably to the high inherent moisture content. This results in an instantaneous liberation of moisture and disintegration of a portion of the fuel into small particles which becomes an intimate mixture of air, water vapor, and volatile. The distillation, so to speak, reduces the weight of the remaining solid particles of the lignite by approximately 50 per cent. The portion of the fuel burned in suspension, of course, is a function of coal size as fired. The remaining particles, principally carbon and ash, fall to the grate and are burned in the ordinary manner. This type of combustion is a general characteristic of spreader stokers firing with all fuels, but with lignite the portion burned in suspension and the potential fly ash carry-over is substantially greater.

Firing Pulverized Lignite

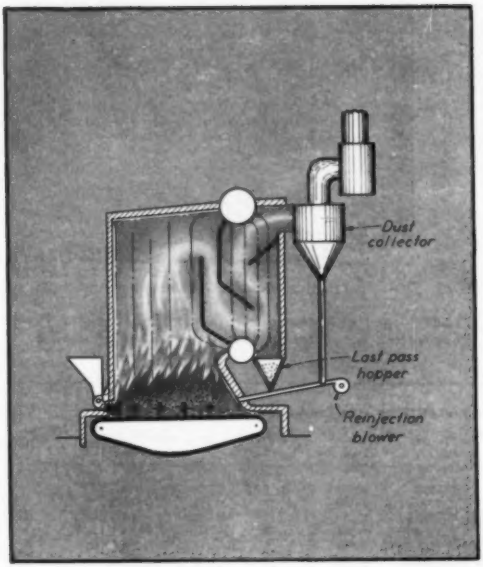
During the period when stoker installations were being developed to their present standard, sporadic attempts were made to apply unit pulverizers. They were unsuccessful mainly because of failure to analyze basic problems involved, and because of certain misconceptions concerning the requirements of a pulverized coal furnace when handling high moisture fuels.

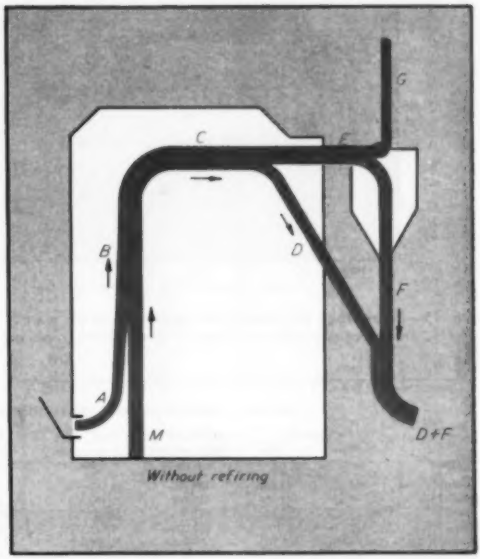
First, it was erroneously assumed that fuels having moisture content of 40 per cent or above could not be handled without pre-preparation and particularly pre-drying. Second, there was the mistaken conception that high refractory temperature was a requisite, which retarded the application of fully water-walled furnaces to this service. High "parasite power" required for grinding lignite has also been a deterring factor, since approximately twice the tonnage of lignite must be ground for the same Btu heat release as compared to eastern coals. The early use of preheaters other than tubular types resulted in rapid clogging with heavy deposits of fly ash, which in combination with condensed moisture rapidly resulted in making these air preheaters inoperative.

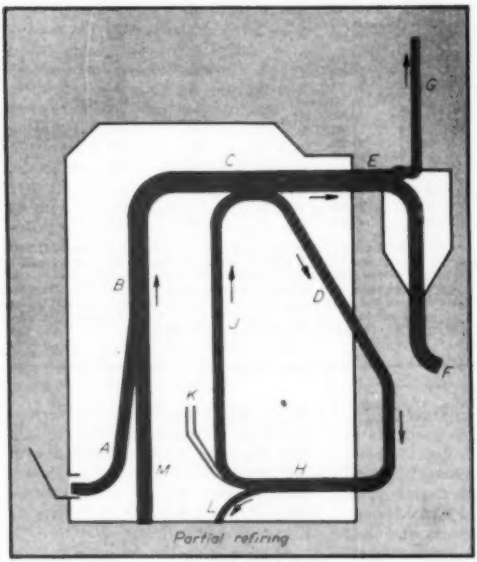
Many of the above problems were recognized and overcome by 1945 when a unit pulverizer lignite installation was completed at the Crookston Station of the Otter Tail Power Co., Fig. 9. Successful experience with this 75,000 lb per hr unit had no little bearing on the selection of the 230,000 lb per hr, 865 psi steam generator currently being put into operation at the William Neal Station of the Central Power Cooperative at Voltaire, N. D.

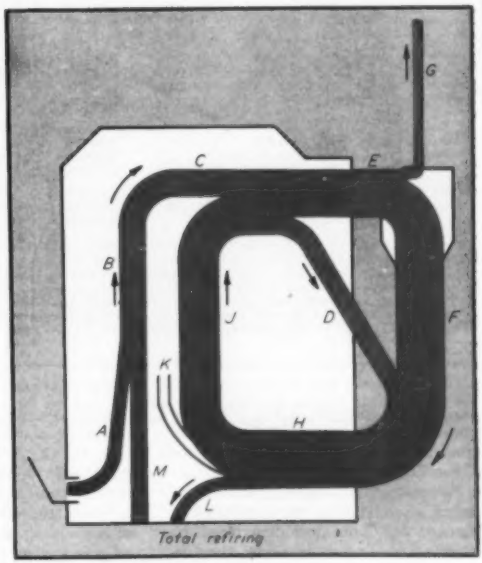
Fig. 9 shows the arrangement of the Crookston unit, which has a capacity of 75,000 lb of steam per hr at 450 psig and 750 F TT. Principal operating characteristics and design data, as well as predicted and actual operating results, are shown in Fig. 7.

Referring to Fig. 9, it will be noted that two air preheaters are used in series. All of the gases pass through the primary air preheater and then through the secondary air preheater. Total air supply passes across the secondary air preheater and approximately 80 per cent thereof is delivered as preheated air at a temperature of 450









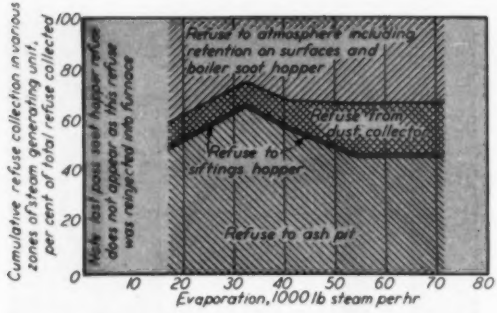
SPREADER STOKER AND SYSTEMS FOR FLY ASH COLLECTION AND DISPOSAL

Fig. 11—Sketch of spreader stoker fired boiler with fly ash collection and reinjection equipment. Fig. 12—No refiring. Fig. 13—Partial refiring. Fig. 14—Total refiring. Nomenclature: A - primary cinder; B - total new dust; C - total furnace dust; D - catch of boiler-pass hopper; E - dust to collector; F - collector catch; G - stack dust; H - refired dust; J - recirculating dust; K - refired combustible burned; L - refired ash to grate; M - dust loss from grate. Large quantity of dust and low combustible in ligaite ash does not make reinjection as attractive as it is for other types of coals

F to the burner plenum boxes. The remaining 20 per cent, after having attained a temperature of 450 in the secondary air preheater, is passed across the small primary air preheater, thereby raising the temperature of the primary air to 700 F. Regulation of final primary preheated air temperature is accomplished by means of a dual damper gas flow regulating device installed between the boiler convection surface and the air preheater.

Combustion Control

Fully automatic combustion control equipment contributes much to the success and dollar economy of firing lignite coal. Typical of such installa-


Cumulative refuse collection in various zones of steam generating unit, per cent of total refuse collected
Refuse to atmosphere including retention on surfaces and boiler soot hopper
Refuse from dust collector
Refuse to siftings hopper
Refuse to ash pit
Note: last pass soot hopper refuse does not appear as this refuse was reinjected into furnace
Evaporation, 1000 lb steam per hr

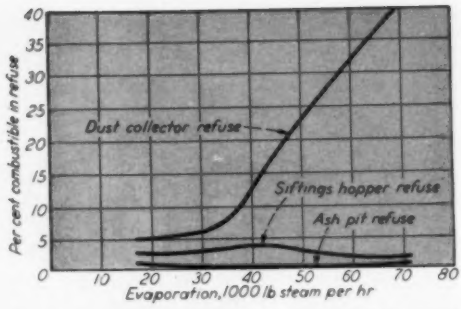

Per cent combustible in refuse
Dust collector refuse
Siftings hopper refuse
Ash pit refuse
Evaporation, 1000 lb steam per hr

Fig. 15—Percentage distribution of lignite refuse by weight (left), and of combustible in refuse (right) during tests on 72,000 lb per hr steam generator at the Minnkota Power Cooperative Inc., Station located at Grand Forks, N. D.

TABLE 6 — OPERATING DATA ON LIGNITE BURNING PLANTS IN MONTANA-DAKOTA REGION

Plant	Capacity Kva	Capacity Kw	Electrical generation, kwh Max recorded daily	Electrical generation, kwh Net for year 1950	Lignite burned, tns	Btu per lb lignite, avg.	Btu per kwh, net	Station power avg., %	Avg. efficiency, % Boiler	Avg. efficiency, % Total plant	Notes
Beulah	16,875	13,500	384,000	64,587,596	108,467	7000	23,537	8	72	14.5	A
Bismarck	14,065	11,250	115,000	25,374,300	65,488	7000	33,548	12	74		B
Kincaid	7,500	6,000	91,000	24,923,669	67,334	6500	35,294	11	75	9.7	C
Morbridge	9,375	7,500	150,000	9,027,150	24,106	6550	35,055	8	73	14.2	D
Elson	5,000	4,000	100,000	29,004,000	4,178	6370	18,987	9	73	18.9	E
Fargo	25,000	20,000	291,000	76,001,692	122,328	6962	22,410	15	71	6.5	F
Grand Forks	22,500	18,000	....	53,334,160	89,389	6890	23,097	9	56	14.7	G
Minot	7,500	5,800	....	5,804,619	23,187	6484	51,782	20	60	6.6	H
Crookston	12,500	10,000	214,000	49,688,000	62,312	6600	16,553	10	77	20.7	I
Devils Lake	15,625	12,500	238,000	64,091,000	99,511	6600	20,945	9	75	16.3	J
Harvey	6,250	5,000	90,000	16,499,000	48,267	6600	38,615	12	55	8.9	K
Hoot Lake	9,375	7,500	150,000	49,642,000	56,620	6600	15,054	5	74	22.7	L
Jamestown	10,625	8,500	140,000	40,964,000	65,529	6600	21,116	10	80	16.2	M
Kidder	25,625	20,500	....	82,411,000	131,989	6600	21,141(avg)			16.2(avg)	
							23,500(L-P)	9	57	15.0	
							17,000(H-P)	5	79	20.8	
Ortonville	17,400	15,000		7,073,000	8,330	6600	13,500	5	79	25.0	N
Washburn	10,000	8,000	....	54,289,000	102,819	6600	24,999	7	70	13.7	O
Aberdeen	17,125	13,500	....	70,379,200	96,393	7750	21,400	9	78	17.0	P
Minnkota	26,000	21,500	....	72,600,000	77,000	7000	14,800	7	78	21.0	Q
Valley City	6,200	4,900	70,000	17,018,683	40,000	6600	31,000	8	75	11.0	R
Moorhead	10,312	8,250	....	23,877,700	37,060	7000	21,700	7	80	14.8	

NOTES: (A) Btu per kwh is 18,000 for high-pressure turbine. (B) 50% of steam goes to heating system. (C) Plant does not operate at full load. (D) Plant supplies heating system. (E) Plant is new. (F) 178 heat customers on low pressure; no deductions for steam bled on plant efficiency. Figures in Table are for low-pressure operation. For high-pressure operation: Station power average is 6%; average boiler efficiency is 74%; average overall plant efficiency is 18.5%. (G) Supplies steam to heat customers. (H) Supplies steam to heat customers; shuts down after midnight. (I) This station is new. (J) Some heat customers; one boiler banked at night. (K) Two boilers banked most of the time. (L) New steam plant; hydro-electric station furnishes most of total power requirements. (M) Supplies steam to heat customers. (N) Plant was operating only five months when data in this Table were obtained. (O) Seldom operates at full load. (P) Low cooling capacity. (Q) New turbine installed in March, 1951. (R) Supplies steam to heat customers.

tions is the combustion and feedwater control system shown in Fig. 1 and used at the Ortonville Station of the Otter Tail Power Co.

When burning lignite, overfired air is not essential from the standpoint of smoke, but it is desirable from the standpoint of turbulence in the furnace. The usual method of control of overfired air is from a linkage connected to the stoker control drive or a linkage connected to the forced draft damper control drive. A third method of operation is to provide a separate control drive operated from the master pressure controller.

Fly Ash Control

Most spreader stoker installations have included the use of dust collectors. Arrangements are similar to those in bituminous coal fired boilers, which are shown diagrammatically in Figs. 11, 12, 13 and 14. Fig. 15 shows graphically typical percentages of total ash collection in the stoker ash hopper, in boiler and air heater soot hoppers, in economizer soot hoppers and dust collectors; also, percentage of combustible at each of the points of collection.

The relatively large quantity of fly ash and the low combustible content of the ash does not make reinjection as attractive as with other fuels. A group of samples from a typical stoker fired lignite installation operating at normal maximum load using overfired air, but without reinjection, showed the combustible in the ash caught in the third pass and the air heater ranged from 11.1 per cent to 16.5 per cent, and the combustible in the dust collector catch ranged from 8.6 per cent to 9.8 per cent. Another group of samples from the same installation without reinjection or overfired air showed no noticeable change in the combustible of the catch in the third pass, air heater or dust collector.

With a properly designed furnace, neither the combustible loss nor smoke presents a problem. Early installations used high excess air to reduce furnace temperatures, but current practice is to operate with 14 to 14½ per cent CO_2, or approximately 30 per cent excess air. This may be done without experiencing CO or smoke, and operation at 14½ to 15 per cent CO_2 is not unusual. Boiler efficiencies obtained compare favorably with those obtained with other fuels, after adjusting for the higher flue gas loss due to the evapora-

TABLE 7 — CONSTRUCTION AND ELECTRICAL PRODUCTION COSTS AT TYPICAL LIGNITE BURNING POWER STATIONS

Plant	Name of company	Year built	Last unit installed	Construction cost*	Installed capacity, kw	Cost per kw	Operating costs, mills per kwh: Labor plus miscellaneous	Fuel	Total
Beulah, N. D.	Montana-Dakota Utilities Co.	1919	1949	$2,667,311	13,500	$198	1.56	3.46	5.02
Bismarck, N. D.	Montana-Dakota Utilities Co.	1906	1948	1,741,533	11,250	155			9.14
Kincaid, N. D.	Montana-Dakota Utilities Co.	1928	1948	1,379,434	6,000	230	3.90	2.39	6.29
Mobridge, S. D.	Montana-Dakota Utilities Co.	1928	1950	2,310,669	8,500	272			13.00
Sisco (1)**	Northern States Power Co.	1949	1949	2,113,857	4,000	528	2.58	4.06	6.64
Fargo, N. D.	Northern States Power Co.	1915	1949	3,674,072	20,000	184	2.38	7.50	9.88
Grand Forks, N. D.	Northern States Power Co.	1906	1950	3,712,980	18,000	206	3.67	7.59	11.26
Minot, N. D.	Northern States Power Co.	1900	1930	976,098	5,800	168	18.49	12.02	30.51
Crookston, Minn.	Otter Tail Power Co	1948	1949	3,165,441	10,000	317	2.12	5.85	7.97
Devils Lake, N. D.	Otter Tail Power Co	1947	1949	3,101,277	12,500	248			7.27
Harvey, N. D.	Otter Tail Power Co		1942	660,195	5,000	132	5.06	9.06	14.12
Hoot Lake (2)	Otter Tail Power Co	1948	1948	1,739,722	7,500	232	2.14	5.44	7.58
Jamestown, N. D.	Otter Tail Power Co	1925	1948	2,494,717	8,500	293			8.71
Kidder (3)	Otter Tail Power Co.	1927	1934	2,742,681	20,500	134	2.97	7.60	10.57
Ortonville, Minn.	Otter Tail Power Co.	1950	1950	3,283,098	15,000	219	1.16	5.80	6.96
Washburn, N. D.	Otter Tail Power Co.	1926	1929	1,297,925	8,000	162	2.86	5.61	7.67
Aberdeen, S. D.	Northwestern Public Service Co.		1946	1,940,128	13,500	144	2.80	7.56	9.56
Minnkota (4)	Minnkota Cooperative Power Co.	1949	1951	4,171,000	21,500	194	1.57	4.60	6.17
Moorhead, Minn.	Public Service Department		1949	1,054,781	8,250	128	2.42	7.07	9.49
Wm. Neal (5)	Central Power Cooperative		1951	3,515,000	45,000	167	(New—Costs unavailable)		

*Includes cost of land, buildings and installed equipment.
**NOTES: (1) Minot, N. D. (2) Fergus Falls, Minn. (3) Wahpeton, N. D. (4) Grand Forks, N. D. (5) Voltaire, N. D.

tion of moisture content of the fuel.

The frequency of boiler outages for cleaning are not abnormal. Conventional soot blowers are used in the boiler passes and occasionally furnace wall blowers are also installed. The slag formation in the furnace and slag screens is for the most part of a spongy nature that will drop off during light load periods or can be removed by lancing. Normally, boiler outages for cleaning are not required more frequently than every six months. Lignite from some fields will deposit a hard white scale, principally sodium sulphate, which is readily soluble in water. This will be found in the entire boiler to and including the outlet damper. Many of the plants using this scale-forming type of lignite wash the gas side of the boilers with water during boiler outages. The boiler should be thoroughly hand lanced with compressed air before washing.

In the pulverized lignite fired boilers, burners light off easily and ignition is maintained close to the discharge tube at practically all loads. Ash is delivered to the V-shaped hopper bottom in finely granulated form. Some problems have been encountered in connection with accumulation of fly ash at the upper tube sheet of the primary air preheater. A characteristic of this type of installation is that the zones of fly ash accumulation are different from those encountered in either forced draft traveling grate or spreader stoker practice.

In the latter cases, considerable adherence of fly ash to rear tube banks of units is encountered in zones where an exit gas temperature of 650 F is maintained. In pulverized fuel installations, the accumulation is of a different character, relatively little of it being found adhering to the rear tube bank but a considerable amount of it occurring at the point of reversal of gas flow entering air preheaters. The accumulation within the air preheater tubes proper is relatively limited. Corrosion difficulties in air preheater tubes have not been encountered although there is some evidence of rapid condensation at periods of extremely light loads even though the average exit gas temperature may be above the dew point.

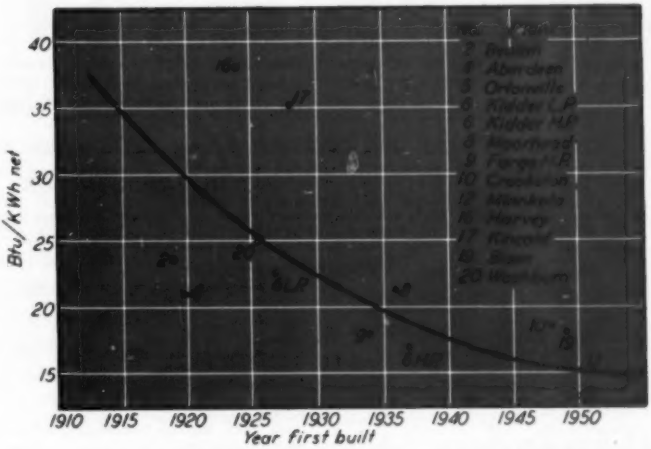


Fig. 16—With improvements in furnace design and application of modern firing equipment, efficiencies of central stations and industrial power plants have improved. Btu per kwh in thousands of listed stations are taken from col. 8, Table 6

Efficiencies and Power Costs

Table 6 lists operating data, boiler efficiencies and overall plant efficiencies at a number of lignite burning stations in the Montana-Dakota region. Important factors contributing either to high or low overall plant efficiencies, are enumerated in the footnotes of Table 6.

Data from column 8 in Table 6 were selected for plotting the curve shown in Fig. 16 which is indicative of higher efficiencies in the more modern plants. It is important to note that plants which furnish steam to a heating system are not included in Fig. 16, because the amount of steam credit for such heating systems varies from company to company.

Harvey, plotted as Station No. 16 in Fig. 16, is the least efficient plant

in the Otter Tail system; two of its three boilers are banked most of the time. On the other hand, Ortonville, which is a new unit and plotted as Station No. 5 in Fig. 16, operates on full load almost continuously.

Production Costs—Electrical power costs at various plants in the Montana-Dakota region are given in Table 7. Costs depend largely on the number of hours the plant is at full load. Current from the Minot steam plant, for example, is nearly five times as much as that produced from Ortonville. The Minot plant at the one extreme produces steam for heating and some electricity, but the entire plant shuts down after midnight. Besides the plant being old, such procedure greatly increases the fuel cost.

Minot has few automatic regulating devices, and ashes have to be removed by hand, which increases the cost of labor; maintenance and repair costs at Minot comprise a large part of the figures given in column 8 of Table 7.

On the other hand, Ortonville is equipped with the most modern automatic controls, and the boilers operate at nearly 80 per cent efficiency on an almost steady load. Consequently, the fuel cost is low, the labor of fewer operators is required, and the "labor plus miscellaneous" item is small.

The plant at Kincaid, N. D. may be considered as a special case. The fuel cost is the lowest of any of the plants listed. Although it is one of the older stations, the cost of producing current is low mainly because fuel comprises the major part of production costs. Fuel cost is low at Kincaid because the power plant has a long-term agreement with the open pit mine alongside the plant.

Construction Costs—Data for construction costs listed in Table 7 are taken for the most part from the records of the North Dakota Public Service Commission, supplemented by data from the Minnkota Power Cooperative and from engineers at various plants visited.

Lignite Research

Several months ago, the U. S. Bureau of Mines $750,000 lignite laboratory at Grand Forks, N. D. was dedicated. First of its kind, it includes a huge pilot plant with ample space for all future lignite projects. Lignite samples from all parts of the country will be graded, crushed, dehydrated, fired and gasified. New furnaces and firing equipment will be tested in full-scale industrial plant set-ups.

Currently, size preparation of lignite is becoming increasingly important, because with spreader stokers there is increasing demand for carefully sized "cuts." Now, with the introduction of pulverized firing, and with the possibility of the introduction of the Cyclone furnace, it is even of greater importance. As a result, the laboratory is actively engaged in obtaining information on the following points:

(1) Fundamental characteristics of lignites which determine their grindability; (2) correlating grindability with performance of crushers and pulverizers; (3) performance of various types of crushing equipment; (4) power requirements to reduce the size of lignite through any given range in the various types of equipment; (5) control of sizes from crushing equipment, as well as consistency of sizes; and (6) shape characteristics of the product from various types of crushing and screening equipment.

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"Combustion Ash Collection for the Small Power Plant," by P. F. Best, ASME Annual Meeting, 1948.

"Fly Ash From Stokers," by E. M. Powell, Combustion, vol. 21, Nov., 1949.

"Application of Overfire Jets to Prevent Smoke from Stationary Plants," by R. B. Engdahl and W. S. Major, Tech. Report VII, Bituminous Coal Research, Inc.

"Methods of Reducing Dust Emission From a Spreader-Stoker-Fired Boiler Furnace," by W. C. Holton and R. B. Engdahl, ASME Semi-Annual Meeting, Toronto, 1951.

"Combustion Engineering," by Otto de Lorenzi, Combustion Engineering-Superheater, Inc.

"Lignite Coal — Power Boiler Applications," by John M. Drabelle, Chief Engineer, Iowa Electric Light & Power Co.

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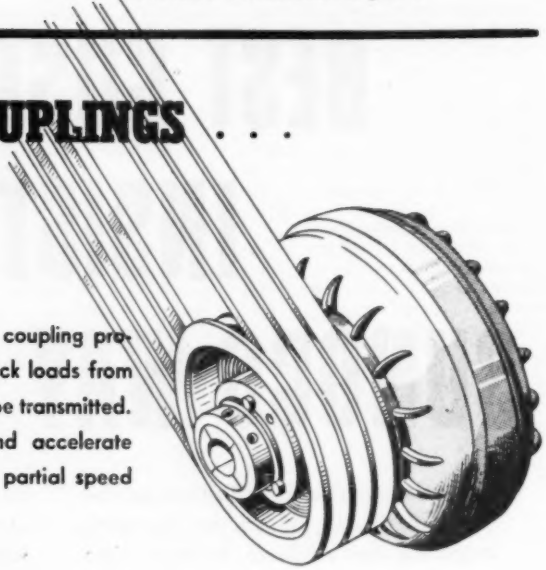


R. A. MOLLER, *Associate Editor*

WHEN A HYDRAULIC COUPLING is incorporated in any drive, it becomes an intermediary between the power source and the driven equipment. Furthermore, a point is provided through which kinetic energy is transmitted into power by means of the mass and velocity of moving oil. Basically, the hydraulic coupling consists of two members, the impeller and runner. The impeller contains multiple blades and is rotated by the incoming power, either from a motor or engine.

Rotation of this impeller causes a steady stream of oil to be thrown against the blades of the runner. The force imparted results in the rotation of the runner; thus, power is delivered to the output shaft. Either the impeller or the runner may serve as the input member, and this ability to transmit power from either side simplifies installation of the coupling.

This coupling installed on the output shaft of a rotated power unit can overcome the problem of inadequate torque or excessive current consumption at starting speeds. In addition, it can serve to cushion the prime mover against the sudden shocks or overloads and overcome momentary demands that would stop the power source.

Cushioning effect protects the mechanism in either direction. Shock loads from the drive side are smooth and cannot reach the prime mover. As the

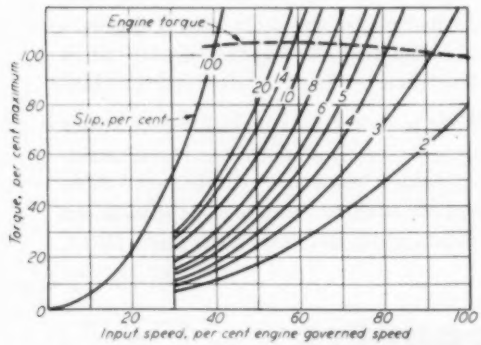


Fig. 1—Curved, sloping lines represent torque capacity for the various values of slip and engine input speeds

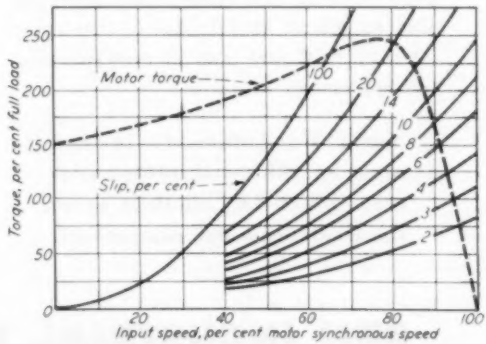


Fig. 2—Performance characteristics for a hydraulic coupling when an electrical motor is employed as a prime mover

shock wave never strikes solid resistance, parts in the given mechanism are protected against severe strain. Torsional vibration from the prime mover is effectively dampened, and smooth power flow is thus obtained.

Typical performance available from such a coupling when used with an internal combustion engine is illustrated in Fig. 1. The curved sloping lines represent the torque capacity for various values of slip and input speeds. The flat curve, near the top of the graph, represents the typical internal combustion engine torque curve. The intersection of the engine curve at the torque curves indicates the per cent of slip in output member operation.

Of particular importance is the relationship between 100 per cent slip of the output member and the per cent of engine speed. Slip of the output member does not decrease until the engine speed has reached approximately 40 per cent of its rated rotating speed. After reaching this speed, the slip rapidly decreases; at 100 per cent input speed, slippage is approximately 2.5 per cent.

Starting under full load, an engine can be cranked easily since the drag torque is negligible at slow speeds. In operation, if the load on the output member should be increased, additional torque would be placed upon the prime mover. This will force the engine to operate at a slower speed where it can supply greater torque. A slower speed to the input of the coupling will result in greater slip. If the load should be increased further, the engine will be pulled down in speed, resulting in still further slip. As the load increases, the coupling will eventually be stalled with the prime mover being pulled down in speed until its torque curve intersects the 100 per cent slip curve. This is the speed at which the engine will operate under full throttle with the coupling stalled, and is generally about 40 per cent of the maximum.

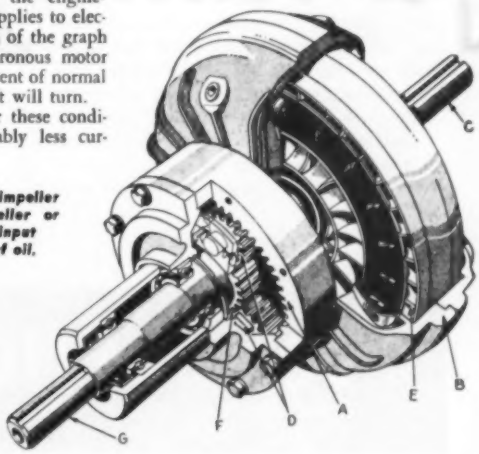
In Fig. 2 is shown the typical performance characteristics of the hydraulic coupling when used with an electrical motor as the prime mover. The same general factors governing the overall performance of the engine-driven application also applies to electrical motors. Inspection of the graph indicates that the synchronous motor must reach about 65 per cent of normal speed before output shaft will turn.

Motors starting under these conditions consume considerably less current during the acceleration period. The available torque in the motor is used primarily to accelerate the rotor; thus, the motor quickly reaches a speed where current demand is relatively low.

Hydraulic couplings can be directly connected between the prime mover and rotated equipment. In such a case, the speed ratio is 1 to 1. However, the unit can be connected indirectly to the driven unit by means of V-belts, flat belts, reduction gears, planetary gears and chains. Regardless of the type of installation, the starting characteristics are the same.—Material for this article supplied through the courtesy of Twin Disc Clutch Co., Hydraulic Div.

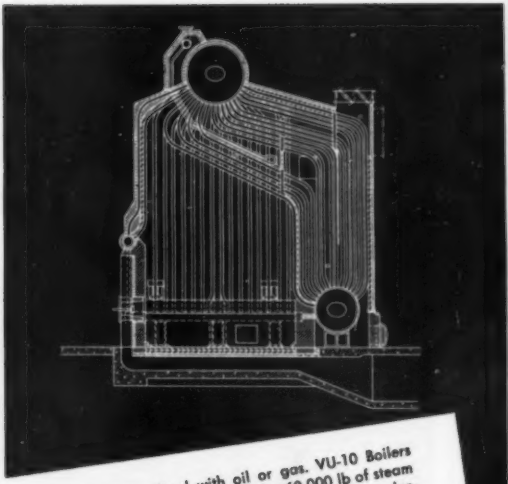
Overhead crane, equipped with a hydraulic coupling as a means of power transmission eliminated pendulum swing as shock loads were isolated and assured even starting torque

V-belt driven cullet glass crusher tied to an electrical power source with a hydraulic coupling reduced starting current 22 amp; running current was also lowered 22 amp

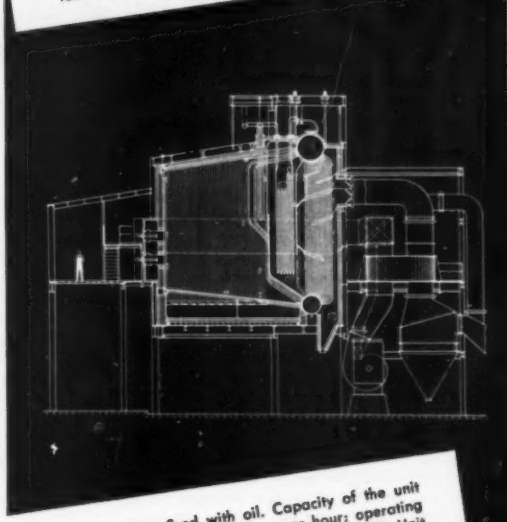


Coupling consists of an impeller and runner. Either impeller or runner can serve as the input member. Steady stream of oil, caused by impeller, rotates output shaft. Planet ring gear A, housing B, and input shaft C are fastened together as input member. Planet gears D are keyed to hydraulic runner E. Sun gear F is integral with output shaft G

One VU can start a family



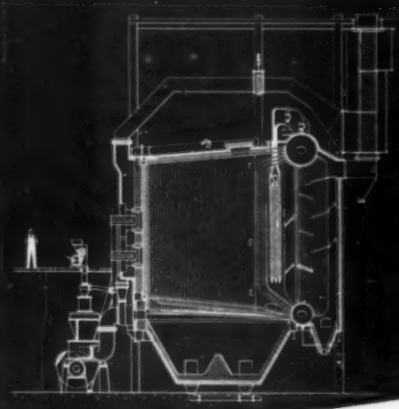
VU-10 Boiler fired with oil or gas. VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hour. They may also be fired by spreader, underfeed or chain grate stokers.



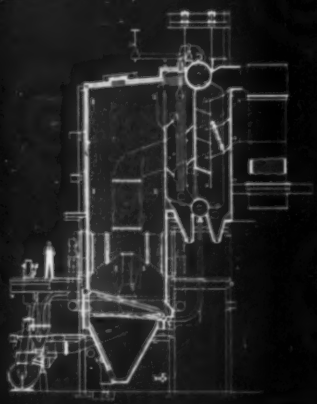
VU-50 Boiler fired with oil. Capacity of the unit shown is 235,000 lb of steam per hour; operating pressure—920 psi; steam temperature—905 F. Unit arranged for future pulverized coal firing if desired.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



VU-50 Boiler fired with pulverized coal. The capacity of the unit shown is 60,000 lb of steam per hour; operating pressure—410 psi; steam temperature—700 F. Unit uses oil as an alternate fuel.



VU-50 Boiler tangentially fired with pulverized coal and/or blast furnace gas. Capacity of unit shown—125,000 lb of steam per hour; operating pressure—850 psi; steam temperature—750 F.

With fuel costing what it does today, it is more important than ever before to select a boiler that will assure the most efficient performance possible. That is why so many companies who watch steam costs closely have acquired sizable families of Vertical Unit Boilers. For example:

A Chemical Company ordered two VU Boilers in 1939. In 1946 five more were ordered for three of their other plants. In 1949 another was ordered for one of these same plants, and in 1950 two more units for a fifth plant. In 1951 three more units were ordered for still another plant — thirteen units for six plants in twelve years!

An Electric Utility Company ordered its first VU in 1941. In 1945 it ordered a second VU for a different plant. For another of its plants one unit was installed in 1946 and two more in 1947. In 1949 a VU was installed in a fourth plant, and in 1950 one was installed in a fifth plant. A total of seven boilers in five different plants.

A Sugar Company ordered two VU Boilers for one of its plants before the war. In 1946 it ordered a VU for a second plant. And in 1950 another VU was installed in this same plant.

A Steel Company now has a total of fourteen VU Boilers in four different plants. Starting with an installation of two units in the early thirties, it has reordered six times. The most recent installation of two units at one of its plants was completed in 1948.

* * *

This is just a small sample of the hundreds of companies that have ordered and *reordered* the VU Unit. They have found *through their own experience* that the advanced design, sound construction and consistent reliability of the VU Unit mean *lower steam costs*. Once you have a VU in service you soon know why it is that so often *one* VU starts a family. B-494

— SUPERHEATER, INC.

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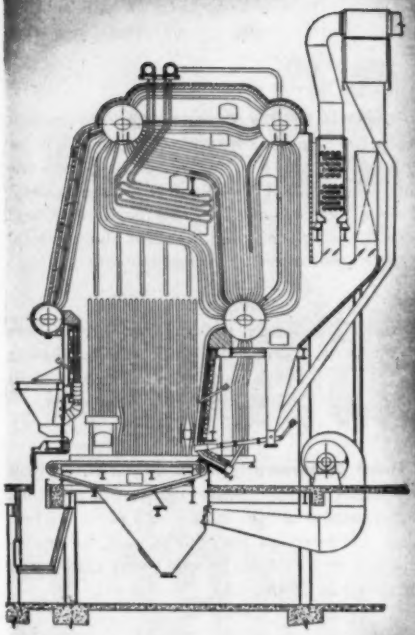
C-E

UNION STEAM GENERATORS AT BURROUGHS . . .

33 Years
of UNION Service



Burroughs Adding Machine Co.
Have Used UNION Boilers Since 1917

33 years ago The Burroughs Adding Machine Company installed their first Union Boiler. Periodically since 1917 they have added more Union installations. The latest Union "N" Type boiler equipped with Detroit Stoker is operating in the Detroit Burroughs plant.

The history of Union Boilers in constantly expanding business organizations the country over is similar to the Burroughs story.

Obviously the product gives satisfaction.

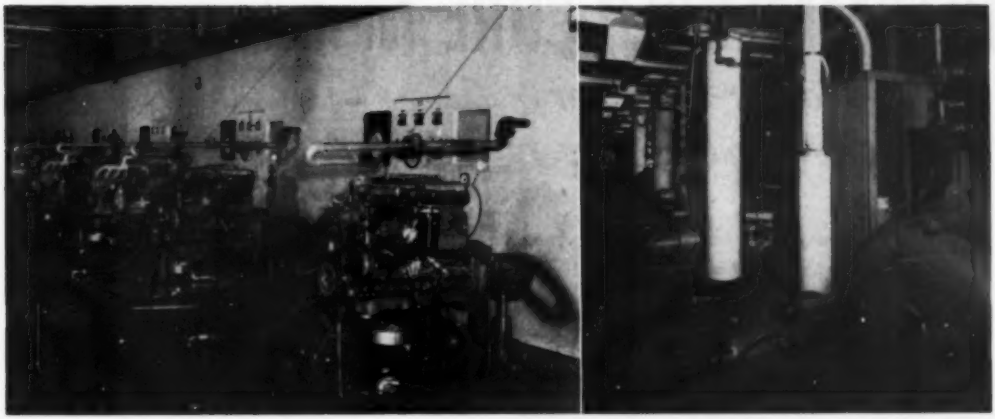
You will do well to select Union Boilers because Union's 60 years of engineering and manufacturing experience goes to work for you in an installation which fulfills your requirement perfectly.

Consult with our engineers . . . you can depend on Union to serve you well.

UNION IRON WORKS . . . *Since 1890*

373 CASCADE STREET • ERIE, PENNA.

BOILERS • PROCESS EQUIPMENT • FABRICATED STEEL



Several of the 44 engine testing stations where every motor is given the equivalent of a severe road test are seen at the left. During break-in, the truck engines drive dynamometers shown at the right, and energy generated during the tests supplies more than 40 per cent of the plant's electrical and heating requirements through motor-generators

SALVAGING WASTE DYNAMOMETER POWER

Forty-four truck engines on test produce a lot of energy. This company uses the output of the dynamometers to help carry the plant power load

ENGINE POWER tests create a considerable amount of energy which is normally dissipated in resistors. When International Plainfield Motor Company, subsidiary of Mack Trucks, Inc., undertook a now complete 700,000 sq ft expansion program including a 44 station engine test building, electrical equipment was provided to allow use of the energy in the plant electrical system.

The Motor Test Building, designed and constructed by the Wigton-Abbott Corporation along with the rest of the project, is specially built to subject every truck engine to the equivalent of a severe road trial before it leaves the plant. The bank of dynamometers which absorb the power developed during the tests supply more than 40 per cent of the plant's electrical and heating requirements. The motor-generator and switchgear room where output from the test block dynamometers is fed into the plant's power system is housed in an adjacent building.

Facilities for supplying the engines under test with gasoline and diesel fuel, water, coolants and recirculating filtered oil are all located in a covered trench in front of the stations and piped to the engines as shown in the upper left photograph. Quick change connectors make installation and removal of the engines a simple matter. By continuously reconditioning the lubricating oil, abrasive particles picked up during the break-in period are removed and the quality of the oil is maintained.

Each of the stations rests on an 8 in. thick steel plate mounted on an 8 ft thick concrete block. A layer of cork separates the steel from the concrete in the mounting designed to cushion vibration of engines under test.

After the test period, during which each engine has contributed its share of power while proving itself, no additional break-in time is needed on the road.

Electrical control room contains 4160 v feeders, a-c and d-c motor-generator sets and switchgear that allow power generated in test room to be used in the electrical system

Engines are lubricated by oil piped to test stands. Pumps at right circulate the oil which is purified in equipment at left and cleaned by the centrifuges at the rear of room

RECOMMENDED CURE for the high cost of air

. . . Cooper-Bessemer Motor Driven Compressors

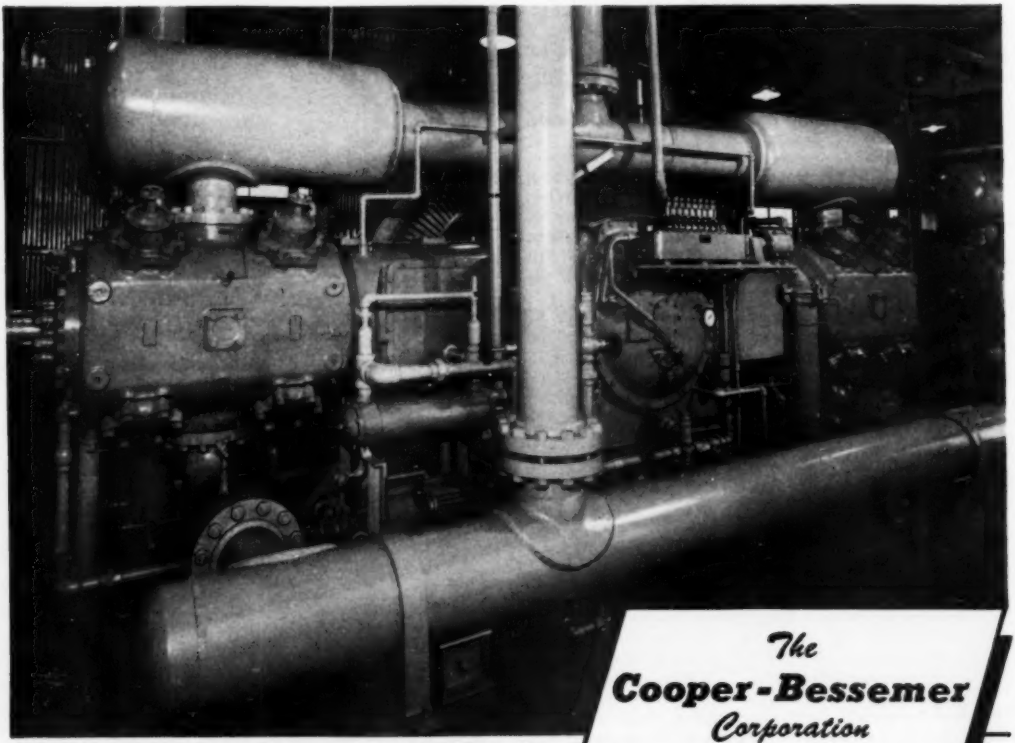
IF your plans call for large scale compressed air on a long-range basis, better have a close look at the savings modern Cooper-Bessemer units offer. Shown above is one of the various types and sizes from 350 to 3000 horsepower.

These motor-driven units, like Cooper-Bessemer engines and engine-driven compressors, are designed and built for years of the hardest service with an absolute minimum of costly down-time. And that's a major gain right there!

Secondly, these Cooper-Bessemers offer you exceptionally high mechanical and volumetric efficiencies, *throughout* an extremely broad demand range. With such flexibility and efficiency you can turn out more air per dollar.

Finally, these units have unmatched compactness among units comparable in flexibility, efficiency and life! Without sacrificing accessibility or ruggedness, you save on space, housing, installation and piping costs.

Yes, if you're interested in compressing air, get full details . . . add up the money-saving facts on these modern units. The nearest Cooper-Bessemer office will be glad to cooperate.



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MAINTENANCE OF STEEL COLLECTOR RINGS

Poor operation of high speed turbine generators may often be traced to the excitation circuit. Simple but proper care will help insure reliable operation under your particular plant conditions

J. Y. JACKSON, *Generator Engineering Div.*
General Electric Company

Fig. 1—Brush boxes and rigging used with steel collector rings should be adjusted to minimize chatter and sparking

ASYNCHRONOUS generator will be no more reliable than its excitation system, and reliability requires good maintenance of collector rings and brush rigging. There are two important phases in their care: (a) proper recommendations for brush pressure and maintenance by the manufacturer and (b) a planned maintenance procedure program by the operating company.

Modern high-speed turbine generators are customarily built with steel collector rings and radial brush holders. Best operation is obtained when a few simple precautions are taken. Most important of these are keeping the rings and rigging clean and maintaining proper brush pressure. Instructions covering these two essential precautions are summarized for normal use of operators in the box below, and discussed in detail in the text.

General

Collector rings and brush rigging should be inspected frequently to see that operation is satisfactory. It should be ascertained that the brush springs are set for proper pressure, and that there is no brush sparking or chattering. As the brushes wear, the spring fulcrum should be moved downward to maintain nearly constant pressure. Any observed conditions which might interfere with the proper operation (oil vapor, oil or dust near the rigging or rings, or ring vibration) should be corrected.

Brushes should be inspected more carefully at regular intervals to see that they do not stick in their holders and are well fitted. Those making poor contact should be sanded and refitted to the rings. New brushes should always be fitted before use. It is important that the correct grade recommended by the manufacturer be used on high-speed collector rings.

During shutdown periods, rings should be examined for excessive pitting, threading or grooving, or foreign matter or deposits. In severe cases, rings will have to be ground or turned, and then polished. Minor cases can be cleaned by dressing the rings at rated speed with fine sand paper (grade 1/0 or finer) followed by polishing with crocus cloth and cleaning.

Rings and rigging should be cleaned

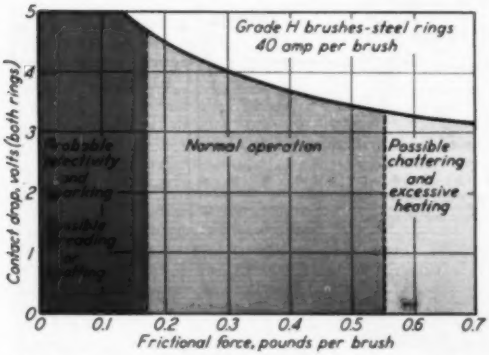


Fig. 2—Proper brush pressure is not a critical value but may have to be adjusted for changing atmospheric conditions

SUMMARY OF COLLECTOR RING CARE

1. Keep collector rings and brush rigging clean. Keep oil, oil vapor, dust and other harmful materials away from rings. Clean rings during shutdown with a cloth dampened with alcohol, and keep rigging blown clear of dust and wiped clean.
2. Set brush pressure from 1 to 2½ lb depending on the type of collector ring, atmospheric conditions and brush grade.

Then:

a. Maintain the selected pressure if operation is good. Check frequently.

b. Increase pressure if brushes spark, or if rings begin to thread or groove.

c. Decrease pressure if brushes chatter.

during each shutdown. Surfaces between the collector rings should be cleaned periodically or at every shutdown. Brushes should always be lifted to avoid electrolytic pitting of the rings if the unit is down for a long period, and must always be removed while the rings are being polished or cleaned.

Brush Rigging

Radial type brush holders used on high speed alternators should be adjusted in accordance with the manufacturer's recommendations. As a rule, holders should be set normal to the surface of the ring with a clearance of 1/8 in. between brush box and ring surface. A radial setting for the holder allows friction between the brush box and brush to be reduced to a minimum. The 1/8 in. clearance between the brush holder and ring surface minimizes any tendency of the brush to chatter.

During down periods brush holders, bushings, studs and bus rings should be checked to make sure they have not become loose. Loose rigging is dangerous and causes spotting and undue wear of the brushes and rings.

Brush Pressure

Proper pressure is important. The recommended value is normally given by the manufacturer of the generator. It has been found that brush performance is closely related to frictional force between the brushes and rings. Good operation is obtained over a rather wide range of force, but poor operation may result if the value is either too low or too high, Fig. 1

If frictional force is too low, contact voltage drop is high. In this region the brushes will probably spark and some of them will tend to carry all the current. Sparking, in turn, causes rapid roughening of the collector rings, either in the form of pitting, threading or grooving, or dark deposits resembling brush marks on the ring. On the other hand, forces that are too high will result in brush chattering and possible overheating of the rings, which will have a dark glossy appearance. Chattering may chip the brushes

From the preceding discussion, it is evident that the brush pressure should be increased if sparking occurs or if the ring surfaces begin to roughen. Conversely, pressure should be decreased if brushes chatter. Since the coefficient of friction can change with atmospheric conditions, vibration and the like, the operator must maintain the proper frictional force for good operation by adjusting brush pressure. Under usual operating conditions, there is a fairly wide range of brush pressure which yields good operation, usually obtained by the pressure recommended by the manufacturer. In exceptional cases, generally associated with unusual atmospheric condition, a higher or lower pressure based on experience may give best results.

What to do until the doctor comes

Emergency methods that may keep your equipment running after a breakdown until the permanent repairs are made

WATTMETER SUBSTITUTES FOR SURVEYOR

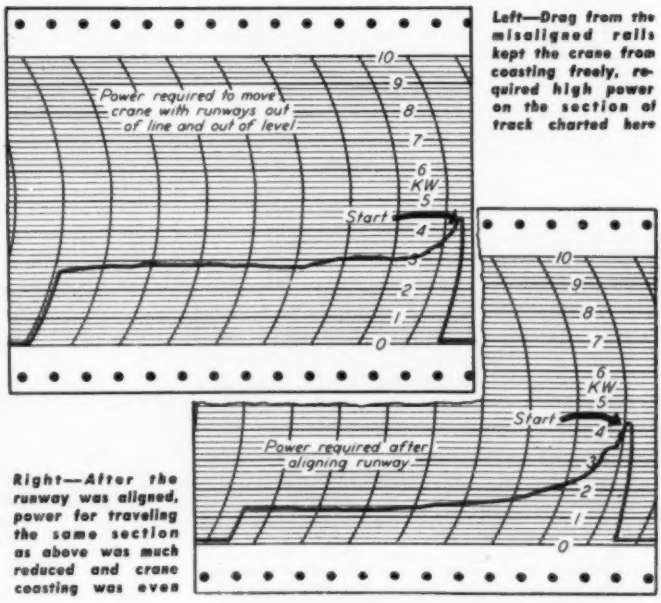
• Instruments and meters often perform services beyond the intention of their design. In this case a recording wattmeter took the place of a surveyor.

Rails of a traveling crane were not in proper alignment. It was impossible to "spot" the load accurately because the crane would not coast uniformly. Many starts, stops and reversals caused excessive braking, unnecessary wear on controls and wasted power. Realignment called for a surveyor—but none was available. Production depended on the crane.

A graphic wattmeter, used for other purposes, was connected in the travel motor circuit. By running the crane, track sections causing resistance were accurately reflected in the power record. While the faulty sections were being aligned, the wattmeter checked progress of the operation.

After track alignment, the crane came smoothly up to speed and coasted freely. The charts showed low even consumption of power (except in starting) by the travel motor.

Supplied through the courtesy of The Esterline-Angus Company, Inc.



Left—Drag from the misaligned rails kept the crane from coasting freely, required high power on the section of track charted here

Right—After the runway was aligned, power for traveling the same section as above was much reduced and crane coasting was even

BEARING LUBRICATION

(Continued from page 75)

thus conducting lubricant to the bearing.

The same inspection, lubrication and cleaning procedures apply to this type bearing as was mentioned for wool-packaged bearings. Sometimes the end of the wick that rests against the rotating journal will become glazed and fail to conduct oil to the bearing. The remedy for this is to cut the glazed portion from the wick with a sharp knife.

Most ball and roller bearings are lubricated with grease but some employ oil. The oil level should be maintained in such bearings at the height shown in Fig. 4. Inspection, lubrication and cleaning of these bearings is the same as for ring-oiled bearings. However, extra care is necessary to keep grit from bearing parts.

Some vertical journal bearings are submerged in oil. In others, action of the rotating journal pumps oil from a reservoir to the top of the bearing from where it returns to the reservoir by gravity.

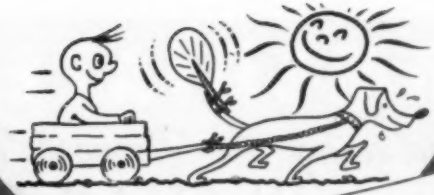
Other journal bearings are provided with a constant supply of lubricant by gravity or pressure circulation. Generally, the oil is recovered after passing through the bearing and used over again. However, in the force-feed lubricator arrangement, oil is used only once.

Ordinarily, such bearings and oil supply systems should be inspected, replenished and cleaned according to the same schedule as suggested for ring-oiled bearings. Special attention should also be given each time to the oil circulation and supply equipment.

Journal bearings of reduction gears are generally lubricated by flow or splash of the same oil that is employed to lubricate the gears. The oil level in such equipment should be checked weekly and oil added as required, the gears being stopped whenever the oil level is being checked or lubricant added.

Once a year, the gear case should be opened and the oil drained. Bearings, gears and interior of the case should be flushed with warm light oil before adding fresh lubricant.

Inspection, lubrication and cleaning of bearings suggested herein apply to ordinary operating conditions. For other conditions, follow special instructions from equipment manufacturers or lubrication engineers. Where operating conditions are more than ordinarily severe, the frequency of maintenance procedures should be proportionately increased.



What Other Drive Gives You...

1. BY-PRODUCT POWER

Power to drive pumps, blowers or stokers...auxiliary electrical supply for special needs...off-peak or standby generating capacity—these can be obtained almost free by utilizing the By-Product Power available through Troy Steam Engines.

Steam used for heating or processing packs plenty of horse power as well as B.T.U.s. Under the right conditions, Troy Steam Engines can extract this latent power while actually improving the heat balance. By-Product Power can be converted into A.C. or D.C. electricity by efficient Troy Generating Sets, or it can be utilized directly to drive stokers, fans, pumps, blowers, kilns, compressors, mixers and similar equipment. With the Type EN Governor, constant speed can be maintained accurately; or speed can be automatically varied over an exceptionally wide range.

Double duty: Steam drives high pressure pumps and provides heat for processing in this installation of multiple Troy Steam Engines in the Port Arthur refinery of The Texas Company.

Plus-

2 HIGH STARTING TORQUE

3 UTMOST FLEXIBILITY

4 SIMPLICITY, LONG LIFE

5 ACCURATE, FAST SPEED CONTROL

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If your drive needs any or all of these five characteristics, the modern Troy Steam Engine is indicated. Send us your drive requirements and steam conditions, and our engineers will be glad to recommend the right type and size Troy engine to meet your needs.

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KEYSTONE

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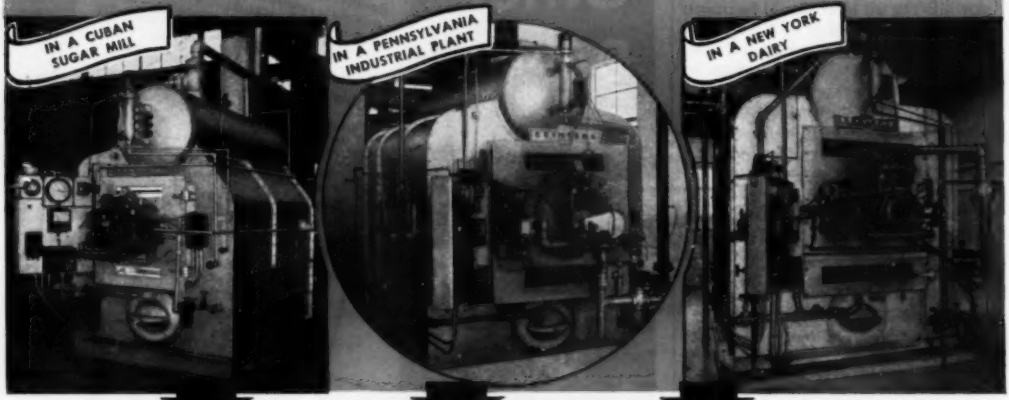

Developed Boiler Horse Power	75	100	150	200	250	300	350	400	450	500	600	700	800
Heating Surface Sq. Ft.	357	500	750	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000
*Capacity Lb./Hr.	2490	3320	4980	6640	8290	9950	11,610	13,290	14,940	16,620	19,930	23,220	26,550
Overall Length — A	14'-10"	14'-10"	19'-6"	19'-6"	20'-0"	22'-0"	22'-0"	23'-0"	24'-8"	25'-0"	25'-6"	25'-6"	26'-4"
" Width — B	6'-3"	6'-6"	7'-1"	7'-8"	7'-8"	7'-8"	8'-9"	8'-9"	8'-9"	9'-0"	9'-8"	10'-3"	10'-3"
" Height — C	9'-5"	9'-9½"	9'-9½"	10'-3⅛"	10'-3⅛"	10'-3⅛"	11'-3¼"	11'-3¼"	11'-3¼"	11'-3¼"	12'-7⅛"	12'-7⅛"	12'-11½"
Upper Drum Dia.	34"	34"	34"	34"	34"	34"	34"	34"	34"	34"	38"	38"	38"
Lower Drum Dia.	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"	28"	28"	28"
Dia. Gas Outlet	10"	12"	14"	16"	18"	20"	22"	24"	26"	28"	30"	32"	34"
Shipping Weight Lbs.	20,000	22,000	25,000	27,000	28,000	30,000	33,000	36,000	44,000	52,000	60,000	65,000	70,000

*Based on Feed Water at 212°F and Steam at 100# psi. *Conservative ratings based on 5 sq. ft. per developed hp.*

It's a 2-drum water tube boiler with integral water cooled furnace. Gases travel 3 lengths of the boiler—scrubbing 5 bare metal heat absorbing zones. It's complete—needs only service connections—burns oil or gas or both—requires no stack—no special foundation.

Write for booklet **SB38C.**

COMPLETE STEAM POWER PLANT EQUIPMENT

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Complete Steam Generators • Type C 3-Drum Boilers • Types VL & VC 2-Drum Boilers • "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • "Keystone" Packaged Steam Generators • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

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Handbook for engineered plant services

Methods, data and ideas that make excellent references in solving engineering problems frequently encountered in plant operations

Parallel Operation of . . . .

RECIPROCATING COMPRESSORS

TWO OR MORE reciprocating refrigeration compressors are often installed for parallel operation. Reasons include:

1. Where sufficient capacity is not available in a single machine to carry the cooling load on large systems.
2. Where power lines cannot carry the starting current of a single large motor, and two smaller motors can be started in sequence.
3. Where fluctuating loads require two or more units to be operated in sequence, loading and unloading step-by-step.
4. Where a stand-by machine, needed for emergency use or during unusual peak loads, must be paralleled into the system.

Whatever the reason, installing more than one reciprocating compressor in a single refrigeration system calls for careful planning to insure efficient operation. Among the important points to watch are lubrication, suction headers, liquid and discharge lines and compressor crankcase heights.

Lubrication

Pressure in crankcases of multiple compressors should be maintained equal by an oil equalizing line, as shown in Fig. 1. This is to prevent varying crankcase pressures from causing a difference in crankcase oil levels. A difference of only 0.5 lb can cause a 15 in. oil level difference. And with varying oil levels come varying rates of compressor wear and tear.

Where compressors with different crankcase heights have to be installed, the units should be mounted on bases that compensate for their heights. This will maintain equal oil levels.

Oil leaves compressors at different rates, due to variations in piston wear. This oil, mixing with the refrigerant, is carried along the refrigerant piping until it returns to the compressor crankcases. It is important to arrange piping so that oil, in its passage through the system, will not be pocketed or trapped in elbows, bends and turns.

Suction pressures should be equalized by a hook-up such as shown in Fig. 1, thereby assuring return of oil in equal amounts to each compressor. The oil equalizer line shown in Fig. 1 should be used only with machines having a single equalizer tapping at the crankcase; also, the tapped hole should be so located that the bottom edge of the hole just touches the normal oil level. Do not use a single line equalizer on machines having two equalizer tappings—use instead two equalizer lines.

In addition to the equalizing line, oil pressure protectors should be installed. These units are pressure differential devices that operate between suction pressure and oil-pump discharge pressure. When the pressure differential drops, the unit shuts off the compressors.

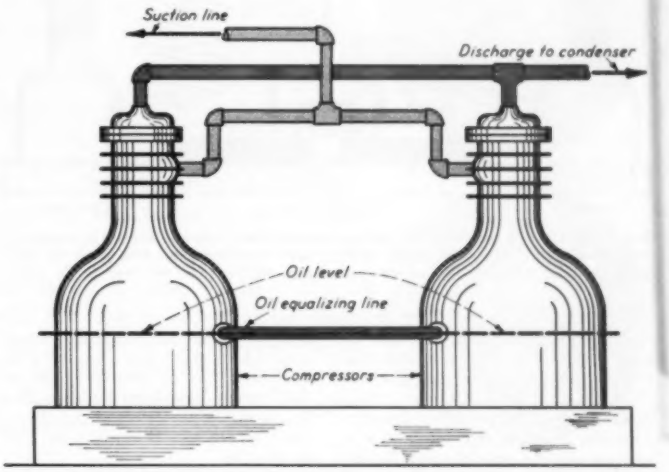


Fig. 1—Use this piping hook-up to equalize suction and discharge pressures when operating reciprocating refrigeration compressors in parallel. Oil levels must be equalized, thus preventing lubrication difficulties. Also use oil pressure protectors

Tie-in Pressure Lines

For best results, the various gas and liquid lines should be manifolded to obtain equalized pressure; that is, the discharge pressures from the compressors should be equalized as shown in Fig. 1. Where two receivers are used,

Data and information for this article were obtained through the courtesy of Lee Gatewood, engineer, The Trane Company.

Handbook for engineered plant services

Methods, data and ideas that make excellent references in solving engineering problems frequently encountered in plant operations

(Continued from page 113)

Parallel Operation of . . . .

RECIPROCATING COMPRESSORS

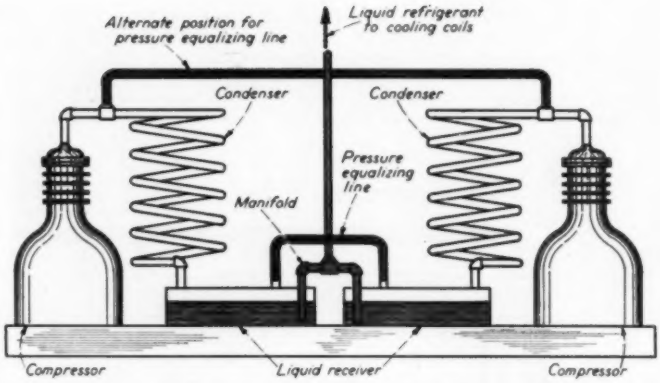


Fig. 2—Where two receivers are used, equalizing lines should be hooked up as shown here to maintain the same liquid level in each receiver. This also prevents high pressure from building up and forcing refrigerant from one receiver to the other

receiver equalizing lines should be used as shown in Fig. 2 to maintain the same liquid level in each receiver. This also prevents high pressure from building up in one condenser that may force the liquid refrigerant from one receiver into the other through the interconnecting liquid lines. If enough liquid is lost from one of the receivers, hot gas will blow directly from the condenser into the liquid line. Since an expansion valve can pass many more pounds of liquid than it can of gas, the introduction of gas to the liquid lines reduces their capacity considerably.

Install Water Feed Regulators

When condensers are installed in parallel and with multiple compressors, water feed regulators should be installed so that each condenser will receive the exact amount of water required to condense the refrigerant gas. This conserves water.

Lines to and from each compressor should be properly valved so that each compressor can be isolated in case of breakdown. The down unit can then be cut out of the line and the rest of the units can take as much of the load as possible.

Control Techniques

When paralleled compressors are installed on a single piping hook-up supplying chilled water to a zoned system, compressors can be controlled by a thermostat in the cold water return line. Individual room control can be obtained in this case by room thermostats. These thermostats control the amount of chilled water which enters or by-passes the cooling oil. Then, when cooling demands decrease on one side of the building, room thermostats by-pass larger amounts of the chilled water around the coils. As the temperature of the chilled return water goes down, the thermostat on the return line, which can be of the modulating type, unloads each compressor in accordance with the load.

Larger air-handling cooling units can be controlled in much the same way. Where direct expansion coils are used, the only difference in control is that as the suction pressure in the return goes down, a suction line controller unloads each compressor. However, in this case, face and by-pass dampers can be controlled by room thermostats. As they by-pass air around the direct expansion coils, the suction pressure is lowered.

While direct expansion coils are less expensive, chilled water systems are safer. Chilled water equipment is generally recommended for any installation where more than one cooling unit is handled by a single refrigeration system, whether compressors are paralleled or not. Chilled water jobs lend simplicity to control, minimize maintenance, and provide ideal operating characteristics.

In general, when paralleled compressors are installed on a single refrigeration piping system, suction and discharge pressures should be equalized, crankcase pressures should be equal and lubrication should be given extra attention. Where possible, however, it is best to install reciprocating compressors singly, thereby simplifying piping, lubrication and control problems.

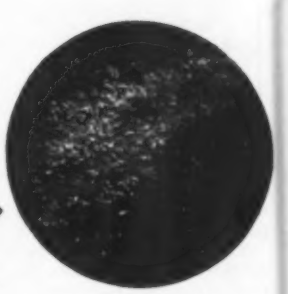
DON'T CLIP—DON'T TEAR
WRITE FOR TEAR SHEETS!

Rather than spoil this issue for other readers in your plant, let us supply you with copies or tear sheets of any of the articles for your files. Just drop a line to the editors, preferably on company letterhead, for articles desired.

Will Corrosion, Carryover or Tube Failure Tie-Up Your Boilers This Month?

Whether you operate high or low pressure boilers . . . corrosion, carryover and tube failures are mighty expensive . . . not only in tube replacement and installation costs, but in loss of valuable production time.

These photomicrographs show how proper treatment can reduce tube failures.



On this tube from a high pressure boiler, iron oxide particles have deposited as magnetic iron oxide "scale." Even when distilled make-up is used, this type of deposit frequently occurs, causing tube failure. Although the conventional alkali-phosphate-organic treatment was used, it did not prevent deposits from adhering.

This is a tube operating under similar conditions except that the boiler water has been treated with Drew Complete Boiler Water Treatment. This treatment chemically alters iron oxides—and other types of deposit formations. It makes them non-adherent and eliminates costly tube failure.

Send for new DREW ORGANICS *folder describing the use of organics in modern boiler water treatment. Write today.*

Whether you operate high or low pressure boilers . . . whether your tube failures are caused by iron oxides or any other type of deposit . . . you'll find that Drew can provide a practical, economical solution to your water conditioning problems. Thoroughness of investigation, proper treatment and frequent service have made Drew one of America's fastest growing water treatment companies.

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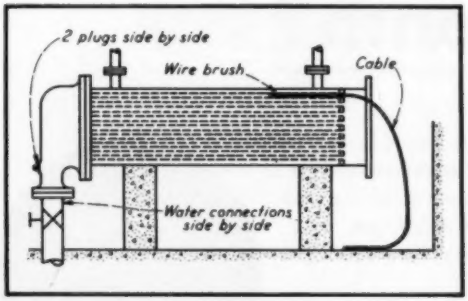
Improvised short cuts that are practical solutions to your operating and maintenance problems. We pay $10 on acceptance of each idea

Cleaning Oil Cooler Tubes

One of our turbine oil coolers is located in such close quarters that the tubes could not be cleaned without dismantling the head end of the cooler. In order to save hours of work in removing the head end of the cooler, we cleaned



the tubes from the opposite end by using a brass-wire shotgun cleaning brush on a stiff stranded wire cable.

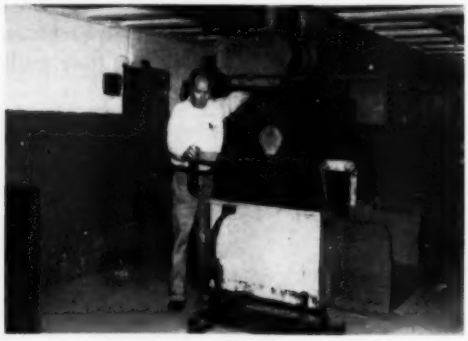
The cable was stiff enough to push the brush through the tubes but could still be readily coiled out of the way as the brush was withdrawn. We completed the cleaning by flushing the tubes with a water hose. Removal of two pipe plugs in the head end of the cooler allowed the loosened sludge to be washed out.

Carl Tretinyak, Austin, Minn.

Battery Damage Eliminated at Wallingford Steel

The Wallingford Steel Co., Wallingford, Conn., has designed a simple, home-made battery rack for its "walkie" batteries and has effected a "short-haul" layout for placing "rider-driver" truck-batteries on charge. These achievements not only eliminate manual handling of industrial truck batteries, but also gain maximum usefulness of every cubic foot in the 15 x 25 x 8 ft battery alcove.

The battery rack is made of structural steel members



mounted on casters. Upright members are spaced so that "walkie" batteries can be lowered between them. As shown in the illustration, these members cradle the batteries so that it will not fall when the rack is pushed from the "walkie" unloading point to the charger.

Large (5, 6 and 8 ton) platform trucks pull up to an all-metal stop, mounted on verticle I-beams set in the concrete floor, where their batteries are changed. The stop prevents incoming trucks from accidentally ramming and damaging batteries being charged. For lifting, lugs at the ends of platform-truck batteries are engaged by pick-up elements situated at the ends of a spreader-bar. To save head room, the spreader-bar is attached directly to the hoist pulley housing rather than to the usual hoist hook. The spreader-bar, equipped with pick-up elements located approximately 1 ft in from each end of the bar, is also used to change "walkie" batteries.

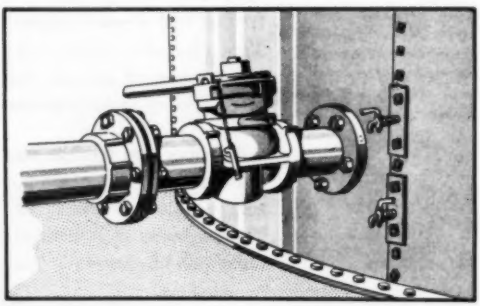
Discharged batteries from the large trucks are conveyed a maximum distance of only 20 ft and lowered for charging. The electric hoist is trolley mounted on an overhead I-beam to move batteries mechanically to and from the center of the alcove.

Courtesy of Gould-National Batteries Corp.

Checks Fuel Oil by Using Tank Thief Valves

Here is a method whereby a plant engineer can determine the amount of water in his diesel fuel tanks without running a "thief" from the gage hatch at the top of the tank.

Install a pair of ¼ in. valves along the vertical bolt line of the tank. Make two strips of 2 x ⅜ in. steel, long enough to cover three bolt holes, and drill them to fit three consecutive holes in the tank seam. Use the two outer holes for bolting the steel strips to the tank, and fit the center



one with a stopcock. A gasket of oil-resistant material can be used behind the steel strips to provide the necessary seal.

By placing the two valves above and below the level of the flange which carries the fuel line to the plant, it is possible to draw off a sample of the fuel either just above or just below the level of the fluid entering the plant main. The engineer can then ascertain the amount of water and/or other impurities present in the oil.

E. T. Pate, Houston, Tex.

MECHANICAL SEALS

(Continued from page 78)

manufacturers if a plant engineer has a specific problem which he wishes to check without disturbing his process other than to put in a by-pass line.

A number of years ago double seals were employed wherever the pressures exceeded those which were useable under unbalanced seal conditions. A double seal consists of a seal mounted next to a pump impeller and another one at the bearing end of the stuffing box with fluid at a pressure normally above that of the pump suction inserted between the two seals. Usually this requires a separate source of pressure to put oil or similar fluid between the seals and greatly increases the cost and complications of the installation.

This type of installation has been used where abrasives have been present in the pumped fluid. Because the pressure is higher between the double seals than in the suction area of the pump, clean fluid rather than the fluid containing abrasives will tend to flow through the seals.

With further advances in balancing seals and providing wearing faces which are extremely resistant to abrasion, the double seal is rapidly being replaced. It is still used to some extent where extremely hazardous fluids are being pumped. In such applications, the chamber between the seals is flushed with the fluid, thereby controlling leakage and giving an indication of failure of the inner seal. However, there are few jobs which cannot be done today with a single seal.

IGNITION VOLTAGE REGULATION

(Continued from page 81)

by the capacitor switching operation, but also the longer swings caused by this and other a-c supply disturbances. While the tests were being run, load drawn by the dynamometers was changing through a range of 200 to 1200 amp. These variations produced no detectable effects on the test dynamometer circuit.

A more direct indication of what this can mean in the reading of instruments is illustrated in Figs. 7 and 8. Each reactor has a shorting switch which can be closed to avoid unnecessary heating during power runs. The photograph of the dial in Fig. 7 was taken with the reactor shorted out of the circuit. The exposure was several seconds and shows some of the blur caused by torque variations, although greater swings of the needle actually took place but were too rapid to be recorded on the film.

The photograph in Fig. 8 was made under the same conditions but with the reactor in the circuit. The needle was steady and could be easily read to the required accuracy.

In order to produce the desired results, the engineers met both the known and unforeseen problems step-by-step, improving either accuracy or speed of response each time. Each individual step resulted in a system whose characteristics would be quite satisfactory for many industrial applications. The ultimate result was an electronically regulated ignitron rectifier with a sensitivity of plus or minus 0.1 v in 250 v (or .04 per cent) and a response time of less than 3 c. The cost of the rectifier and the series reactors is less than 60 per cent of a multiple motor-generator system for similar dynamometer applications.

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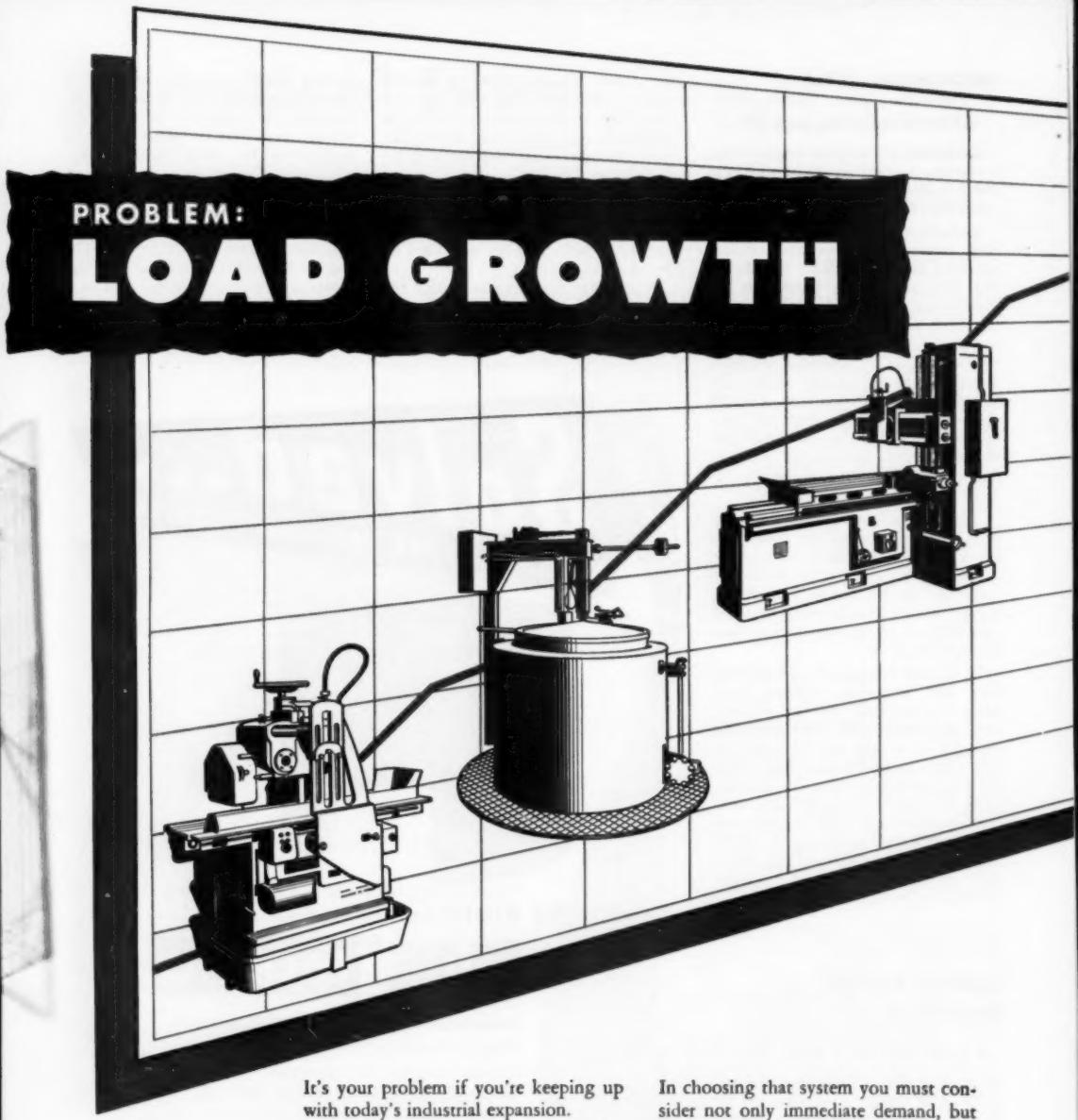
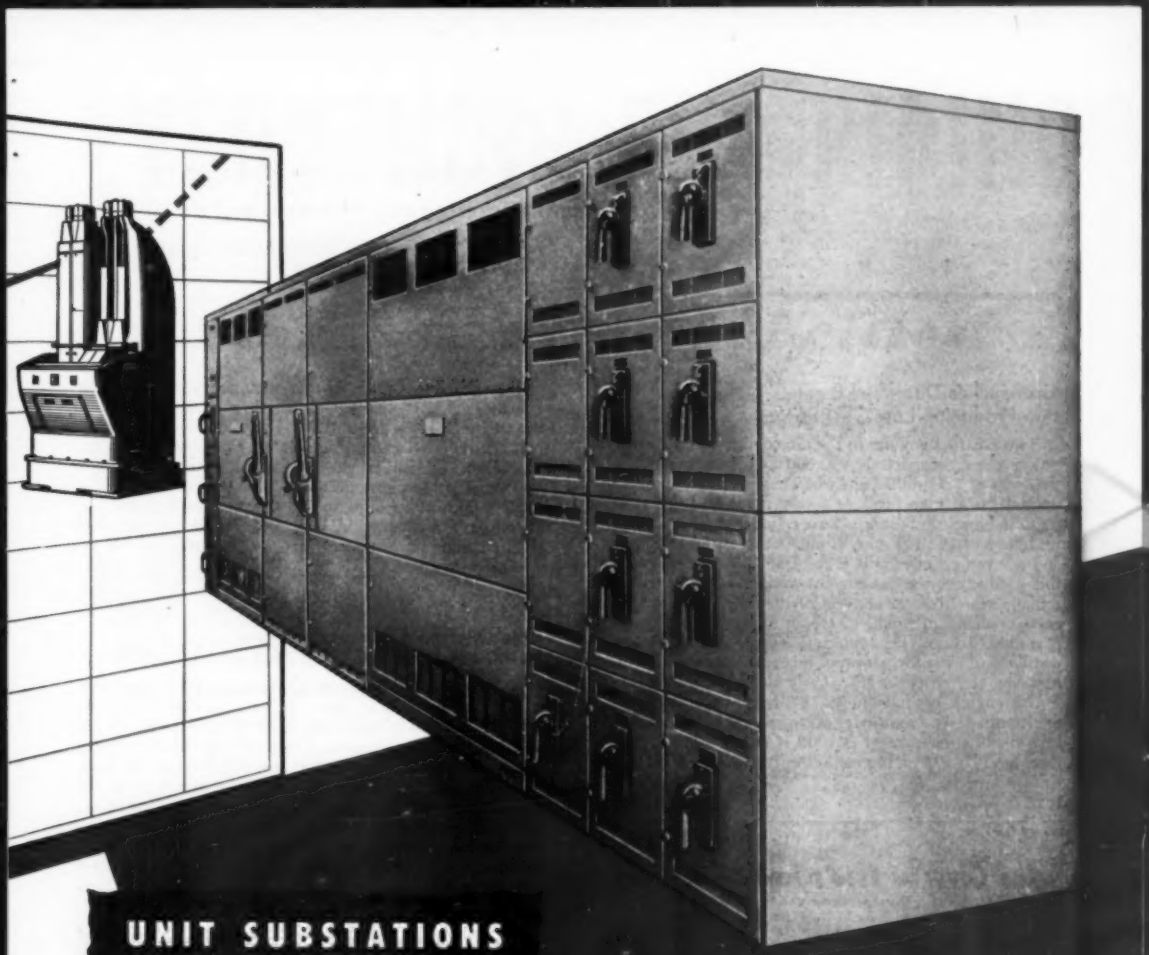


It's your problem if you're keeping up with today's industrial expansion.

And when new production machinery adds load upon load to your electrical system, your planning naturally includes installation of a unit substation system. In choosing that system you must consider not only immediate demand, but also future expansion. The system must be designed and engineered to meet your specific requirements, flexible enough to be expanded for future needs.

THE ANSWER: I-T-E UNIT SUBSTATIONS!

I-T-E Catalog 9000 describes all types of secondary unit substation equipment, offers concise, easy-to-use information on selection of distribution systems and equipment. One page alone, on cost comparison of basic power distribution systems, may save you weeks of investigation and reduce initial investment. Send for Catalog 9000. I-T-E Circuit Breaker Company, 19th and Hamilton Sts., Philadelphia 30, Pa. Subsidiaries: Railway and Industrial Engineering Co., Greensburg, Pa.; Eastern Power Devices, Ltd., Toronto.



UNIT SUBSTATIONS

The I-T-E Company

Spot news

Short, "boiled-down" paragraphs on the most interesting recent events and developments in American industrial plants.

Greenville's Dual-Fuel Engines Are Producing Low Cost Power

Two Duafuel engines in the Greenville, Texas municipal power plant generated 17,992,000 kwh last year at a total fuel cost of 1.73 mills per kwh. These two-cycle units burn natural gas at high pressure with a small quantity of pilot oil to stabilize combustion. A six cylinder engine, with 21½ in. bore and 29 in. stroke, is rated at 2400 hp at 225 rpm, and a seven cylinder unit is rated at 2800 hp. To achieve this production, the gas engines worked a heavy schedule, actually more than 95 per cent of the time. Also the city is close to abundant supplies of both oil and natural gas and pays only 12.5 cents per 1000 cu ft for gas. The 36-38 gravity distillate oil used for pilot fuel is expensive by comparison, however, at 9 cents per gal.

Gas engine production was 83 per cent of the plant's total output. The remainder was generated by three Nordberg diesel engines rated at 1000, 1450 and 2000 hp. All three are 17½x25 in. mechanical-injection two cycle Diesels.

Pilot oil flows by gravity to a 4000 gal supply tank from a 50,000 gal storage tank, and then through duplex filters to the engines. There are individual pilot oil injection pumps for each cylinder, permitting accurate metering of the small oil charge. The natural gas is regulated, metered and fed to three-stage compressors on the engines where it is raised to 1150 lb pressure for injection into the cylinders. Admission of the gas is controlled by hydraulic actuator pumps. Both engines, built by Nordberg, can be converted to full oil operation if necessary.

The Cover — Esso's Fawley Refinery

• This month's cover illustration shows one of the copper chloride sweetening units at Esso Petroleum Company, Limited's Fawley refinery in Britain. Equipment includes a 66,000 bbl per day single-stage crude distillation unit and a 60,000 bbl per day two-stage crude distillation unit, both of which went "on stream" a few months ago.

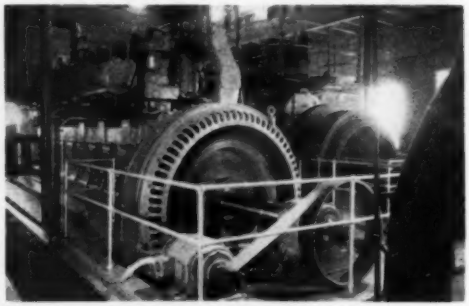
The sweetening units are used to remove organic sulfur compounds from crude oil, as well as from natural and cracked distillates; also, to deodorize natural naphtha fractions of the crude oil. They aid in the recovery of approximately 600 tons of sulfur per day.

Engravings for the cover illustration were obtained through the courtesy of the Foster Wheeler Corp., which cooperated in the design and construction of distillation, sweetening, extraction, catalytic cracking and other processing units at the Fawley refinery. Currently, three Foster Wheeler 110,000 lb per hr, 150 psi, 465 F TT steam generators are being installed. Each unit will consist of a two-drum water-tube boiler equipped with superheater, air heater, soot blowers and burner equipment. The steam drum is 60 in. inside diameter, while the inside diameter of the water drum is 36 in. The water-cooled furnace will have an effective volume of 5520 cu ft.

One Dual-Fuel Engine Operates 98 Per Cent of the Time at Colby

Last year a dual-fuel engine was the mainstay of the Colby, Kans. municipal power plant. This unit operated 8,442 hr out of a possible 8760, a record of 96.37 per cent of the time. The engine generated 3,766,000 kwh, 83.21 per cent of the plants total, at a total fuel cost of 3.71 mills per kwh.

This engine, installed in 1949 to take advantage of the low comparative cost of gas, is a seven cylinder, 16 x 20 in., two cycle, pump scavenging, Fairbanks-Morse dual-fuel engine. It has a normal sea-level rating of 1,400 hp at 300 rpm, but was slowed down to meet Colby's preference for a slow-speed engine and rated at 1118 hp at the city's 3120 ft



Dual-fuel engine, rated at 1118 hp, supplies 83 per cent of annual power load at Colby, Kan., municipal station

altitude. This engine burns natural gas and a small quantity of pilot oil.

The natural gas used has a heating value of 960 btu per cu ft and costs Colby 21.1 cents per 1000 cu ft. It reaches the plant at 50 psi, is reduced to 30.5 psi and metered and then piped to the engine throttle valve. The quantity of gas admitted is controlled by the governor to meet load variations. Special small-volume fuel pumps send a constant,

(Continued on page 122)

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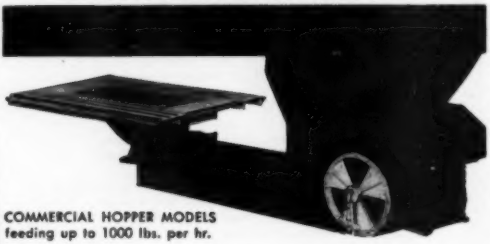

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feeding up to 1000 lbs. per hr.

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Yet you can cut those costs . . . cut them up to 30% . . . with Combustioneer Automatic Coal Stokers. Think of that saving . . . monthly . . . or *yearly!*

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Hopper and bin-feed models, capacities up to 1000 lbs. per hr. Write us today for further information about how Combustioneer is saving money in your specific kind of business and can save money for *you.*

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Spot news

(Continued from page 120)

accurately-metered charge of pilot oil to initiate combustion. In the event the gas pressure fails, the engine automatically switches over to oil and utilizes the regular diesel fuel injection pumps. A diesel fuel of 34-36 gravity is used for pilot oil and for the oil-burning engines in the plant. It is stored in three underground tanks, transferred by motor-driven pumps to elevated day tanks in the engine room, and piped by gravity through individual meters to the engines.

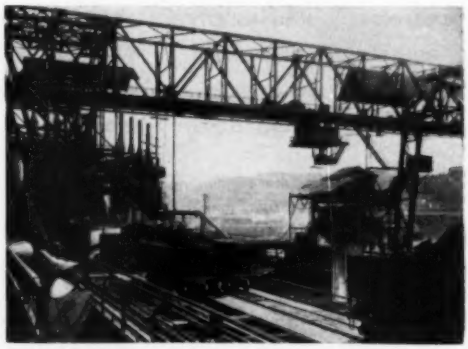
World's Largest Presses to Be Hydraulically Powered by Triplex Pumps

The largest presses in the world will be used in die forging airplane parts at Wyman-Gordon, North Grafton, Mass. These giant forging presses, a 75,000 ton and a 25,000 ton press, are expected to achieve a production rate previously thought impossible. They will either forge heated billets of aluminum into a die or extrude them through dies to form required shapes.

To hydraulically power the 75,000 ton press, five 3¾ x 24 in. stroke horizontal double acting triplex pumps are required. Each of these, manufactured by Worthington Pump and Machinery Corp., Harrison, N. J., has a capacity of 490 gpm against a discharge pressure of 4500 psi, and is driven by a 1500 hp direct-connected, synchronous motor.

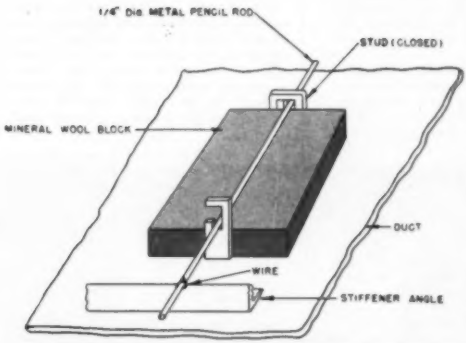
Air Duct Maintenance Costs Cut By Internal Insulation Technique

Engineers of the Public Service Electric and Gas Company of New Jersey have adopted a simple, ingenious application technique to reduce the possibility of expansion cracks and accidental damage to thermal insulation on sheet-metal air ducts. Block-type mineral wool has been applied to



ORE BRIDGE HAS 1165 TON HOURLY CAPACITY

New 15 ton ore bridge to serve Carrie blast furnaces Nos. 6 and 7 at US Steel's Homestead District Works near Pittsburgh. It has a 186 ft span, and supplants two 7½ ton ore bridges. Dravo Corp., Pittsburgh, fabricated the structure except main span which was built by American Bridge Co.



Insulation was applied inside sheet-metal air ducts to the boilers in this power plant. Drawing illustrates technique used in holding blocks of insulation in place

the *inside* of the large secondary air ducts at the 300,000 kw Sewaren generating station. As a result, repair time and maintenance costs have been held to a minimum; inspection of the lining takes place only once a year.

To apply internal duct insulation, open rectangular studs were welded to the inside duct surface on 12 in. centers, as shown in the drawing, and mineral wood blocks were inserted between the studs and tightly butted together. Long metal pencil rods were inserted in the stud openings over the insulation. The studs were then closed to hold the pencil rods firmly in place against the blocks. Stiffener angles on 24 in. centers were welded to the duct surface midway between alternate rows of studs and the pencil rods wired to them. The insulating blocks were then painted with a waterproofing material. To complete the installation, expanded metal lath was wired to the pencil rods as a key for a 1 in. thickness of refractory cement. — *Courtesy of the Industrial Mineral Wool Institute.*

Overfire Jets for Smoke Abatement Is Subject Matter of New Booklet

As a part of its program to further the improved utilization of bituminous coal, Bituminous Coal Research, Inc. has published a booklet on "Application of Overfire Jets to Prevent Smoke from Stationary Plants". This booklet covers the principles for the design, construction, and application of overfire jets that apply to both hand-fired and stoker-fired furnaces for smoke prevention. It includes the basic informa-

(Continued on page 152)

will put your PUMPING OPERATIONS on a PAYING BASIS

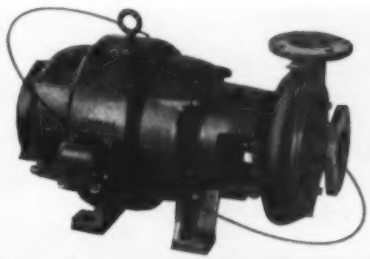
he's a

WEINMAN SPECIALIST

This man . . . symbolic of the entire WEINMAN organization . . . has the latest pumping information at his fingertips. He can look at your present liquid handling equipment and tell you whether it is making you . . . or costing you . . . CASH DOLLARS. Professionally he lives alone . . . with centrifugal pumps . . . and likes it. For pumps, the ONLY product made by WEINMAN, constitute a challenge that has kept every key man and department head completely absorbed for the past tweny-five years.

There's a WEINMAN design that best does your pumping job. YOU and your WEINMAN representative should establish this important production link at the earliest opportunity. Together you can put all of your pumping operations on a paying basis. Write, wire or 'phone.

GENERAL SERVICE UNIPUMP



Because of its compact design the WEINMAN Unipump is extremely useful where installation space is limited. It is sturdily built and works against heads up to 500 feet at economical cost. Sizes up to 1000 G.P.M.

Built by Centrifugal Specialists

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News
of men and companies

SOCIETIES

American Welding Society—C. H. Jenninga, engineering mgr, welding dept, Westinghouse Electric Corp., was elected president for 1951-52. Other officers elected were: E. R. Seabloom, Crane Co., 2nd v-p; J. U. Durham, American Bureau of Shipping, v-p, southern district; A. P. Maradudin, Standard Oil Co. of Calif., v-p, western district; E. N. Adams, American Institute of Steel Construction, v-p, New York and New England district; T. B. Jefferson, Editor of Welding Engineer, v-p, mid-western district; R. S. Green, Ohio State University, director; and M. S. Shane, Cleveland Electric Illuminating Co., I. O. Oehler, American Welding & Mfg. Co., E. O. Williams, Victor Equipment Co., directors-at-large.

ANNIVERSARIES

Clayton Manufacturing Co.—Marked its twentieth anniversary in November.

HONORS

American Welding Society—W. H. Bruckner, University of Illinois, received the 1951 Lincoln Gold Medal. This award is made annually to the author of the paper judged to be the greatest contribution to the advancement and use of welding for the year. The award is named for its donor, J. F. Lincoln, president, The Lincoln Electric Co.

American Petroleum Institute—Lieut-Gen. E. O. Thompson was named as the 1951 recipient of the "Gold Medal For Distinguished Achievement." The citation, which is presented annually to some outstanding American is regarded as one of the nation's top industrial awards.

Aluminum Company of America—Carnegie Institute of Technology's Merit Award for "worthy achievement" has been presented to T. D. Jolly, in charge of engineering and purchases.

Allegheny Ludlum Steel Corp.—Four employees were presented with awards in recognition of their outstanding achievements on behalf of the company. The awards, which include a citation from the board of directors, "The President's Medal," and $1,000 in cash, were presented to A. Herres, associate director of research; S. Gormly, assistant chief metallurgist at the Dunkirk N. Y., plant; and I. G. Shoff and J. Eagleson, mgr and asst mgr of the hot mill department of the West Leechburg, Pa., plant. The latter two won their award jointly.

The B. F. Goodrich Co.—H. E. Cook, chief engineer, manufacturing services, was honored recently for having completed 40 years service with the company.

SALES OFFICES

Chicago Steel Service Co.—New general offices and warehouse opened at Kildare Ave. & 45th Street, Chicago. W. D. Monroe, Jr., is president.

American Hard Rubber Co.—Has moved to new offices at 93 Worth Street, New York 13.

Shell Chemical Corp.—Opened new sales office in Atlanta, Ga. M. W. Ellison is mgr of the new district.

NEW REPRESENTATIVES

Eclipse Fuel Engineering Co.— M. K. Griggs Co., 2801 San Jacinto, Houston, Tex., are the new representatives for the Houston region.

Metals Disintegrating Co.—Appointment of American Mineral Spirits Co.,

(Continued on page 126)

EUROPEAN REPRESENTATIVES STUDY POWER CONDITIONS

Difficulties of keeping up with the rapidly increasing power demands of England and France were described by visiting representatives of power authorities of those nations. R. L. Rees, chief chemist of the British Electricity Authority, and R. Rath, chief of the laboratory division of the operations department of Electricite de France, said peak loads in their countries were increasing 10% or more a year. Unable to build new stations fast enough to keep up with these peak loads, government power authorities must exert extreme care to keep all present equipment, some of it 25 or 30 years old, in operation.

The visitors said that variations in the quality of water and coal available complicated their problem. England is having increasing difficulty in finding suitable sites for power plants. The remaining surface water available is "dirtier and dirtier," Mr. Rees said. In neither country is it possible to get a consistent quality of coal.

In a round table conference with engineers and chemists of Hall Laboratories, Inc., the visitors exchanged ideas on boiler water treatment.

Aerial view shows construction at International Nickel's Harbor Island testing station. New equipment will include evaporator, distillation unit and boiler plant

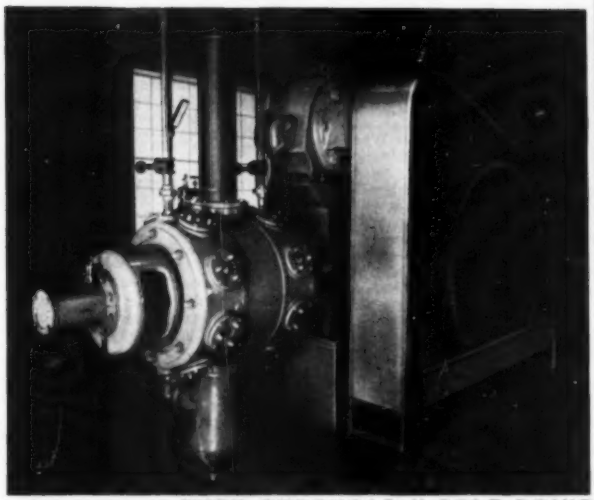
Further facilities for the study of sea water corrosion are being added to the Harbor Island Station of the Kure Beach project, near Wilmington, N. C., it was announced by F. L. LaQue, in charge of International Nickel's corrosion engineering section, under whose supervision the project is operated.

Included in the new facilities will be a full-size salt water evaporator and distillation unit to study the effects of water treatment and design on corrosion and scaling of such units. The equipment will include a boiler plant with a capacity of 4000 lb of steam an hr.

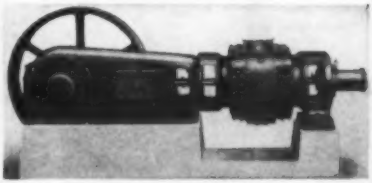
The new unit will be housed in the present laboratory building and, to replace the space thus used, a two-story concrete structure will be erected.

While operated by International Nickel, the 16-year old project has been conducted on an entirely cooperative basis. Specimens from over 100 companies as well as of government agencies have been studied. Technical meetings held several times a year in connection with these studies, have been attended by more than 900 technical experts.

AIR FREE FROM OIL



WITH OVERHEAD V-BELT DRIVE



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Since no oil, grease or other cylinder lubricant is required in CP OIL-LESS CYLINDER COMPRESSORS, they are ideal where it is essential that compressed air be absolutely free from oil to avoid injury to products.

Piston and rod, completely supported by tail rod and outboard crosshead, are full floating, removing all weight from cylinder wall and stuffing boxes. This assures long life of segmented carbon piston rings, with no need for periodically rotating them.

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WRITE FOR BULLETIN 728-8

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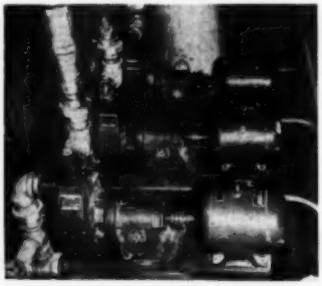
Are you having problems handling high suction lifts? Troubles with volatile liquids or liquids containing abrasives? Difficulties handling sludges or liquids thick with solids?

Ask Marlow engineers for recommendations. Marlow specializes in manufacturing pumps which solve some of industry's most perplexing pumping problems. Marlow self-priming centrifugal and Marlow sludge pumps are exceptional in their capability to make formerly difficult tasks easy.



EXAMPLE — A large New York plant required pumps which would handle vaporous solvent efficiently — without the severe wear and high maintenance costs of other pumps. Marlow self-priming centrifugals provided the ideal answer.

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☐ Please send me literature on Marlow pumps.

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City ..... State .....

MARLOW PUMPS

Leading Manufacturer of
Self-Priming Centrifugal and Sludge Pumps

515 Greenwood Ave. Ridgewood, N. J.

News

of men and companies

(Continued from page 124)

as distributors is announced. Territory covers central eastern area.

United States Rubber Co.—Hajoca Corp., Philadelphia, has been named distributors in the eastern seaboard area.

Yale & Towne Mfg. Co.—Appointment of Baker Equipment Engineering Co. as representatives in the Charlestown, W. Va., area was announced.

EXPANSIONS

Acme Steel Co.—Construction of a $500,000 storage and woodworking building at the Riverdale, Ill. plant is scheduled for completion before next spring.

Automatic Steel Products, Inc.—Acquisition of Metroloy Corporation of New Rochelle, N. Y. was announced.

Blaw-Knox Co.—The Chemical Plants Div. has a contract to provide a propane gas stand-by unit for Westinghouse Electric Corp. at Irwin, Pa.

Boston Woven Hose and Rubber Co.—Has broken ground on a new $1 million rubber reclamation plant at Cambridge, Mass.

Central Hudson Gas & Electric Corp.—Construction of a second 60,000 kw unit at the Danskammer Point steam station has been approved. Burns & Roe, Inc., New York, has been retained as engineers to design and supervise construction of the $11 million structure.

Westinghouse Electric Corp.—New repair and manufacturing plant is currently under construction in Birmingham, Ala. The Daniel Construction Co. of Greenville, S. C. and Birmingham is the general contractor.

Daniel Construction Co.—Has begun construction of a new steam generating station near Monks Corner, S. C., for the South Carolina Public Service Co.

Fairchild Camera and Instrument Corp.—New $3 million plant to be built this year at Jericho, L.I. It is designed by Levitt and Sons, Inc., and will be erected by the Turner Construction Co.

The H. K. Ferguson Co.—Construction has started on a $2½ addition to the Western Automatic Machine Screw plant, Elyria, O. It will increase factory space 180,000 sq ft.

General Electric Co.—Construction has started on new office and warehouse in Portland, Ore. The one-story masonry building, to be occupied by the Lamps Div., will contain 8000 sq ft of office space and 32,000 sq ft for storage.

National Electric Products Corp.—Purchase of the Standard Tool & Mfg Co. plant in Arlington, N. J. is announced. Located on a 20-acre site, there are two main factory buildings, plus 3-story office building.

Pennsylvania Electric Co.—Construction of new Shawville, Pa. power plant is in progress. Completion of first unit is set for the fall of 1953. Four electrostatic precipitators, manufactured by Research Corp., will be utilized. Gilbert Associates, Reading, Pa. are supervising engineers.

Pittsburgh Plate Glass Co.—Formation of a new production unit, the Fiber Glass Div. is now in process. J H. Sherts has been named genl mgr

Stonhard Co.—A 42,000 sq ft one-story building to house offices, warehousing and manufacturing facilities will be erected at the northeast corner of the old Phillies Ball Park, Phila.

Texas Eastern Transmission Corp.—Has awarded contracts to Anderson Brothers Corp. for 217 miles of pipeline, which will complete the 791 mile. 30 in. pipeline from Kosciusko, Miss to Connellsville, Pa.

U. S. Electrical Motors, Inc.—A $3½ million manufacturing plant will be erected in Orange County, Cal. Marsh, Smith & Powell, Los Angeles, are the architects.

APPOINTMENTS

Allis-Chalmers Mfg. Co.—F. C. Ludington has been named mgr of the company's Hawley Works in West Allis, Wis.

American Air Filter Co., Inc.—H J. Noles has been appointed mgr of the Air Filter Div. succeeding the late H. W. Pound.

L. J. Smith H. J. Noles

Chiksan Co.—Appointment of L. J Smith to the newly-created position of Eastern regional sales mgr has been announced.

American Brake Shoe Co.—W. M Black was appointed president and J L. Mullin v-p of Electro-Alloys Div. W. G. Hoffman, formerly div. president was appointed asst to the v-p for research and development.

American Machine & Foundry Co.—A. K. Brown, executive v-p and president of Transducer Corp. of Boston, a subsidiary, has been reelected a board member of the National Industrial Conference Board.

(Continued on page 128)

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BURNER SERVICE

Between - the - Tube
BURNER

The application of the John Zink patented ST Gas Burner to industrial or power boiler installations is a radical improvement in boiler firing.

It is not necessary to form the tubes around the burner to secure maximum heating efficiency. Flame contact is equalized along all heating surfaces.

Furnished in groups of heads. Fires directly over stoker.

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FOR EITHER VERTICAL or HORIZONTAL FIRING

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Full rating may be taken with completely satisfactory fires with either fuel.

Both fuels may b fired in combination if necessary.

A new file and regisetr design permits operation at low excess air.

Any gaseous fuel at pressure in excess of 5 lbs, may be burned.

Any commercial grade of fuel oil may be burned when properly prepared.

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SERIES Y & SERIES YC

John Zink Series Y and YC Combination Gas and Oil Burners are particularly designed for boilers and process furnaces where maximum heat release at low excess air and high heat density place a premium on reliable burner performance at low first cost.

MAXIMUM DUTY — MINIMUM DRAFT.

RUGGED WEATHER-PROOF CONSTRUCTION.

SIMPLE IN DESIGN.

LIGHT-WEIGHT FUEL GUNS ARE EASY TO REMOVE.

BURN ANY COMMERCIAL FUEL OIL.

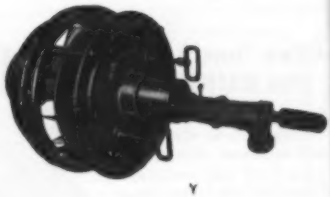
BURN ANY GAS AT REASONABLE PRESSURE.

DRAFT MAY BE NATURAL, INDUCED OR FORCED.

CHROMINUM ALLOY STEELS FOR HEAT & CORROSION RESISTANCE

CENTER FIRING WITH BOTH FUELS ASSURES EQUALLY SATISFACTORY OPERATION WITH EITHER FUEL.

ANY AIR TEMPERATURE MAY BE USED.



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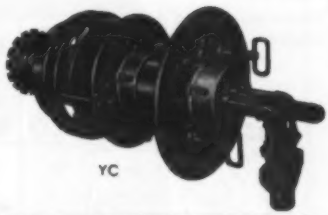

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News
of men and companies

(Continued from page 126)

Charles H. Besly & Co.—R. A. Kenman has been named sales mgr of the Machine Tool Div.

Bogue Electric Manufacturing Co.—Appointment of L. G. Sands as genl sales mgr has been announced.

Morse Chain Co.—L. P. Smith was named mgr of the Ithaca plant.

Boston Edison Co.—T. G. Dignan, formerly associated as an operating executive of various New England electric utilities, has been appointed executive v-p.

Brenholts, Goin & Ogg, Inc.—Recently incorporated company has announced appointment of H. F. Brenholts, president; N. C. Goin and E. V. Ogg, v-ps.

Carrier Corp.—The election of W. Bynum as executive v-p has been announced. He was formerly v-p and genl sales mgr.

Caterpillar Tractor Co.—H. H. Fair was elected chairman of the board of directors at a recent meeting. He succeeds C. L. Best, who died Sept. 22.

Coffing Hoist Co.—J. R. Coffing has been elected v-p in charge of sales, advertising and general office administration.

Cummins Engine Co., Inc.—Announces promotion of the following: W. G. Turner to regional mgr, Great Lakes region; R. A. D'Amour to asst regional mgr, Washington, D. C.; and G. W. Plondke to asst regional mgr, central region.

Dodge Mfg. Corp.—Appointment of J. A. Rozos as director of exports has been announced.

DuPont Co.—E. R. McLean, former asst to the mgr, has been promoted to mgr of the planning section, Nylon Div.

The Feedrail Corp.—Recent appointments include: R. E. Nugent, chief engr; W. R. Jewett, asst chief engr; W. J. Bulanchuk, design engr; and G. H. Baumann, sales mgr.

Foote Mineral Co.—C. J. Conroy has been named sales coordination and export mgr. Promotion of H. C. Meyer, Jr. to mgr of chemical sales is announced also.

General Controls Co.—R. L. Farmer has been named factory sales engr.

Cullman Wheel Co.—Announced election of E. W. Meyers as secy.

General Electric Co.—Appointment of L. E. Newman as mgr of marketing for the steam turbine and generator dept has been announced. A. W. Bartling has been named mgr of product sales practices for the Apparatus Sales Div. Appointments in the Apparatus Sales Div. include G. L Phillippe as mgr of the financial dept and J. R. Squires, as mgr of advertising and sales promotion for the Atlantic district. Announcement of promotions as representatives for the Construction Materials Div. include H. C. Green, assigned to the northeastern district and R. E. Wendling, assigned to the Pacific district. Announcement of the retirement of B. C. Tracey, mgr of accessories and renewal parts sales, has also been made.

Harbison-Walker Refractories Co.—Four new appointments have been announced. W. H. Myers has been named as genl dist supt in charge of six plants, and J. H. Moore, Jr. as genl district supt in charge of coke oven manufacture. C. W. Ayers has been appointed supt of the company's new Windham, Ohio, silica plant and W. N. Bartleson will be supt of the newly acquired plant at Warm Springs, Calif.

Hercules Powder Co.—The Cellulose Products Dept, has announced establishment of an independent branch office in Cleveland with R. L. Huber as mgr.

The Jeffrey Mfg. Co.—The following changes have been announced in the industrial sales organization: L. Kilbourne, formerly mgr of sales, Products Engineering Div., becomes mgr

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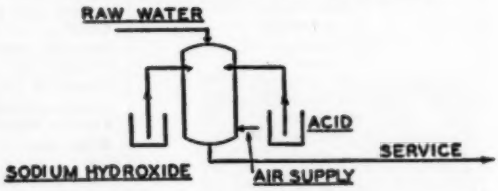
PURER THAN RAIN!



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CLAYTON 1, N. J.

of sales, Conveyor Div.; C. G. Hawley replaces him; L. Cole has been named district mgr of the Jacksonville office, replacing Hawley. P. Lawall, becomes mgr of sales, General Engineering Div. R. W. Sweitzer to be district mgr of the New York office. W. K. Myers, becomes district mgr of the Philadelphia office while P. Hendry becomes district mgr at Boston. D. Knies and A. W. Lemmon have been named consultant sales engrs of the Conveyor Div.

Hunter Spring Co.—Promotion of F. A. Votta, Jr. to chief engr has recently been announced.

Jones Metal Products Co.—At a recent meeting of the board of directors, H. Boyer was elected v-p in charge of sales. L. E. Reed will serve as administrative asst. R. P. Harner will fill the newly created position of director of sales, Abolite Lighting Div.

Lamson Corp.—R. I. Hicks has been promoted to president. He will also continue as v-p of the parent company, Lamson Corp. of Delaware. F. D. Weeks, v-p and treas will assume new duties as chairman of the board.

L & J Press Corp.—W. B. Saul, newly appointed v-p, has charge of production and engineering.

Metallizing Engineering Co., Inc.—J. H. Nill has been appointed southern regional mgr.

D. W. Onan & Sons Inc.—Appointment of G. R. Burda as sales promotion mgr has been announced. Succeeding him as regional mgr of the eastern zone is E. C. Swenson.

B. F. Goodrich Co.—E. G. Hammack has been promoted to mgr of metal parts purchasing. His previous

F. D. Stinaff

E. G. Hammack

post as mgr of engineering equipment purchasing will be filled by F. D. Stinaff.

Miller Electric Mfg. Co.—C. B. Abel, formerly sales mgr, is now the v-p in charge of sales.

Pennsylvania Flexible Metallic Tubing Co.—Announces the election of G. W. Scudder, Jr. to the board of directors.

Columbia-Southern Chemical Corp.—J. F. Dockman and C. F. Bingham have been named asst directors of sales.

Quaker Rubber Corp.—Appointment of H. F. Robertson as comptroller was announced recently.

Read Standard Corp.— C. J. Surdy, v-p in charge of Standardaire Blower Div. sales and engineering, has been elected a director.

Reeves Pulley Co.—J. A. Miller has been made mgr of a new sales and engineering office in Los Angeles. Assisting him will be H. M. Gillis.

Reliance Electric & Engineering Co.—K. H. Myer is named mgr of the Ivanhoe Div. W. H. Haber will succeed him as mgr of the Ashtabula, Ohio, plant.

Seiberling Rubber Co.—E. F. Gates has been promoted to mgr of accessories and repair materials sales.

Sharp & Dohme, Inc.—L. P. Hudson has been appointed to the post of sales mgr of the Baltimore district.

Shaw-Perkins Mfg. Co.—Election of H. E. Park as v-p has been announced.

The Studebaker Corp.—Appointment of P. O. Peterson and K. B. Elliot as executive v-ps has been announced. E. C. Mendler and R. A. Hutchinson have been named v-ps.

United States Air Conditioning Corp.—Announces the following appointments due to reorganization of the company's sales department: L. P. Hanson, v-p and sales mgr of the equipment div., assisted by C. F. Hawk-

(Continued on page 130)

RODA — High grade gas, by-product, steam and household stoker coal from Wise County, Virginia, on the Interstate Railroad.

HENDRON — High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA — High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

GLENBROOK — The Premium Kentucky High Splint unmatched for domestic use. Produced in Harlan County, Kentucky, on the L. & N. Railroad.

COKE — Roda and Stonega from Wise County, Va.

CRITERION COAL — High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

HAMPTON COAL — High volatile domestic, steam and by-product coal from Boone and Logan Counties, W. Va., on the Chesapeake & Ohio Ry.

CROZER — Genuine Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railway.

LYNCO — High fusion coking coal for by-product, industrial stoker and pulverizer use from Wyoming Co., W. Va., on the Virginian Ry.

GENERAL — REG. U.S. PAT. OFF.

ANTHRACITE

Hazle Brook—*Premium Lehigh*
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Capable engineering personnel and the experience gained through long and varied marketing activity assure proper application of one of the above brands and effective servicing of any fuel requirement.

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News

of men and companies

(Continued from page 129)

inson. D. E. Feinberg, v-p and sales mgr and R. D. McLain, asst sales mgr of the packaged refrigeration div. W. Moiselle, sales mgr of the gas div., assisted by A. J. Rocklitz.

Wagner Electric Corp.—Retirement of L. C. Barton, as mgr of the Electrical Div. branch office in Atlanta, was recently announced. W. H. Prewitt, Jr. will succeed him.

Westinghouse Electric Corp.—L. E. Osborne has been named executive v-p in charge of defense products. T. Turner assumes new responsibilities as v-p in charge of mfg and labor relations. J. L. Brown has been named sales mgr for receiving tubes and cathode ray tubes. C. E. Albracht has been appointed mgr of the Western Publicity Division.

Whitney Chain Co.—Appointment of H. W. Beder, Jr. as genl sales mgr has been announced.

Wigton-Abbott Corp.—F. G. Rutan has been named executive v-p.

York Corp.—Election of D. M. Magor to the office of v-p and controller and W. F. Lynne as secy and treas has been announced.

Worthington Pump and Machinery Corp.—Appointment of T. F. Griffin as Holyoke Works purchasing agent was recently announced.

Revere Copper and Brass Inc.—Election of J. J. Russell as chairman of the board and chief executive officer

J. J. Russell J. M. Kennedy

and J. M. Kennedy as president was recently announced.

Clayton Mfg. Co.—W. O. Merritt is named sales mgr of Dynamometer Div. L. Hoban and J. J. Billman are sales mgrs of the Kerrick Steam Cleaner and Steam Generator Divs. respectively. Sales to government activities are under the direction of G. R. Marshall.

Quaker Rubber Corp.—Appointed J. J. Merkel and E. E. Klemm branch mgrs of the Detroit and Cleveland districts, respectively.

Perfex Corp.—P. F. Neess, sales engineering dept mgr of the Controls Div., has been assigned the staff position of product mgr for gas controls.

The American Pulley Co.—Appointment of H. W. Gordon as district mgr in the northwest is announced. S. H. Hewett is named district mgr in the Detroit area.

The Bristol Brass Corp.—R. E. Gay, president has been elected president of the American Standards Association.

The Girdler Corp.—E. T. Beck is the new eastern district mgr of the Votator Div., succeeding S. Welch, who resigned.

The Timken Roller Bearing Co.—S. R. Lyle is appointed to the position of district mgr of the Steel and Tube Div., northern Pennsylvania and New York State district.

OBITUARIES

Kerite Co.—J. R. Walsh, sales engineer, was killed in an automobile accident.

Ajax Electrothermic Corp.—R. N. Blakeslee, 58, v-p and director of engineering died recently.

Youngstown Sheet & Tube Co.—R. M. Welch, 71, former assistant to the president, died Nov. 17. He retired Jan. 1, 1950, after 48 years in the steelmaking business.

LUBRICATION ECONOMY

LUBRIPLATE LUBRICANT
Increased Bearing Life from 2 Weeks to 2 Years!

So says The Globe Company, manufacturer of meat processing machinery. *"In the packing industry where animal acids and moisture quickly destroy anti-friction bearings lubricated with conventional lubricants, LUBRIPLATE prolongs the life of bearings from 2 weeks to 2 years."*

1. LUBRIPLATE reduces friction and wear
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Write today for case histories of savings made through the use of LUBRIPLATE in your industry.

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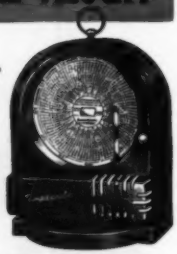


Available in 10 different ranges to cover −30°F to +160°F temperatures, and with spring-operated chart drives for any of the following chart rotations: 8 hours, 24 hours or 7 days.

This entirely self-contained, compact and reliable temperature recorder automatically writes a continuous record of temperature changes on a replaceable chart. Record shows at a glance maximum and minumum temperatures and the duration of temperatures above or below any given point; also shows the exact time of every temperature change and how rapidly it takes place. Recording pen and bi-metallic element are built in hinged, removable door which is also front of instrument. Thus, by merely changing doors it is easy to interchange temperature ranges. Instrument is 8" tall, 5½" wide and 4½" deep. Charts are 4½ inches in diameter.

Write for Bulletin I-715

FLORITE Anemometer

In principle, this unique instrument operates as an anemometer but provides instantaneous, direct readings of air velocity without timing, calculations or reference to charts. Readings are obtained by holding the instrument in the air stream so that air blows against its circular face, causing rotation of a multi-blade rotor mounted in instrument housing. The circular scale surrounding the rotor instantly turns to correct air velocity reading under an index pointer on scale window. Furnished with detachable handle (not shown) and leather case.

Available in two styles: One with a scale of 0-1000 ft./min., and the other with a double scale of 0-3000 ft./min. and 0-35 miles per hour.

Write for Bulletin I-760

BACHARACH Industrial Instrument Co.
7000 BENNETT STREET • • PITTSBURGH 8, PA.

Reviews of recent books

Recent books, published for men responsible for the Engineered Plant Services, are reviewed here. Write to the publisher for those in which you are interested

Water Treatment

"Ion Exchange Resins" by Robert Kunin and Robert J. Myers, Rohm and Haas Co., Philadelphia, Pa. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 212 pages, illustrated. Price $4.75.

The book was written to meet the needs created by the rapid increase in the industrial and research applications of ion exchange that followed the development of high capacity, specific and durable ion exchange resins. It correlates the widely scattered literature on the phenomenon and provides the engineer with reliable information on all phases of ion exchange resins.

Valuable both as a reference and as an introduction to the subject, the book includes theory underlying the mechanism of ion exchange in the resins, usefulness of the resins, operational and engineering data, and methods of using them in laboratory and industry.

Since ion exchange is now being recognized as a valuable unit operation like distillation, absorption and filtration, the authors have incorporated a description of all types of ion exchange resins, including a considerable amount of their own unpublished data on commercial resins.

Water Treatment

"Water Treatment for Industrial and Other Uses" by Erskel Nordell, administrator, Analytical Laboratories, Research and Pilot Plant Div., The Permutit Co. Published by Reinhold Publishing Corp., 330 W. 42nd St., New York, N. Y. 260 pages, illustrated with photographs, sketches and charts. Price, $6.50.

A practical and up-to-date reference work on the conditioning and treatment of water supplies for industrial uses, it deals with impurities (chemical compounds, suspended solids, color, odor and taste) and the method of treatment. Included are the following subjects: water requirements; current water treatment practices in various industries; problems and practices relating to boiler feed waters and cooling waters; processes and equipment used in treating water; water softening processes; chemical reactions and analysis methods.

The material is clearly and simply presented. Basic principles involved and the solutions to specific problems will be of value to executives, consultants, engineers, chemists, operating personnel and students. Extensive tables of conversion factors and equivalents, and other tabular data, complete the book.

Electrical Control

"Manual of Electrical Control", produced and edited by Frank E. Reeves. Published by Electrical Instructions, Audubon Station, Baton Rouge, La. 135 pages plus numerous manufacturers insert sheets. Illustrated with diagrams, charts and tables.

Intended to supply engineers and electricians with an understanding of control circuits, components and their applications, the manual is written in simple language understandable by anyone having a basic knowledge of the principles of electricity and magnetism. The eleven sections discuss theory, construction and application of: symbols and diagrams; electrical contacts; switches; solenoids and electromagnets; relays and contactors; motor controls; pressure and temperature controls; electrically operated valves; electrical controls for air cylinders; time control devices; and count control devices.

The manufacturers insert sheets contain descriptive material and specifications prepared especially for the manual. They supplement the text and serve to present the reader with a great deal of specific information on the devices supplied by the principal manufacturers. Otherwise general statements are thereby given a practical meaning.

Meetings and exhibitions

Announcement of coming meetings that will aid executives and engineers in planning itineraries. For additional information, please write sponsors of meetings

JANUARY

The Plant Maintenance Show will be held at Convention Hall, Philadelphia, Jan. 14-17, 1952. Write Clapp & Poliak, Inc., 341 Madison Ave., New York 17.

MARCH

National Association of Corrosion Engineers holds its Eighth Annual Conference and Exhibition at the Pleasure Pier in Galveston, Tex., Mar. 10-14, 1952.

APRIL

American Society of Lubrication Engineers holds its Seventh Annual Meeting and Lubrication Show at the Hotel Statler in Cleveland, Ohio, April 7-9, 1952.

Put
WILLIAMS-HAGER
flanged
Silent CHECK VALVES
into the Picture-
and your
WATER HAMMER
WORRIES ARE OVER

When you install Wiliams-Hager flanged Silent Check Valves in your water system, you complete the happy picture of a plant . . . rid of costly water hammer. These dependable valves provide positive protection in any position including angular, horizontal and vertical with flow either upward or downward. Disc and seat are renewable—conical spring is non-wearing. Easy to install or reseat, they are available in standard pipe sizes from 1" to 20".

Write today for Bulletin WH-100.

CHECK VALVES

THE WILLIAMS GAUGE CO.

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Steam Traps . . . Pump Governors . . . Feed Water Regulators . . . Water Columns

3166 PENNSYLVANIA AVE. • PITTSBURGH 33, PA.

Materials for Sulfuric Acid

(Continued from page 86)

pound must be soluble to about 0.1 per cent or be peptized. The efficiencies of these inhibitors are quite high at temperatures below 70 C. Compounds of arsenic and antimony have been successfully used as inorganic corrosion inhibitors.

High Silicon Cast Irons

Cast iron containing 14.25 to 15 per cent silicon has been widely used for handling sulfuric acid. Where chlorides may also be present, 3 per cent molybdenum is added to increase the resistance to hydrochloric acid. These materials have been used to handle sulfuric acid at all temperatures and at all concentrations.

Stainless Steel

The stainless steels have been used in increasing quantity to handle sulfuric acid largely because they are less likely to contaminate the acid and because they do not sulfate as readily as iron and steel. However, they have to be used with considerable caution as their corrosion rate is low only over limited concentrations and they tend to be either very good or very poor. Limiting concentrations at which the various AISI types of stainless steel may be successfully used for handling sulfuric acid are shown in the accompanying table.

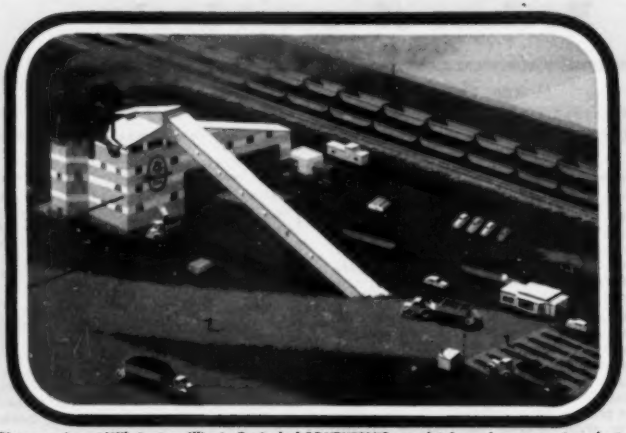
Stainless alloys containing both molybdenum and copper, are useful over a much wider range of temperatures and concentrations. At room temperature they can be used at any strength below 95 per cent; at 150 F below 70 per cent and at 290 F below 0.1%.

Nickel and Its Alloys

Nickel, Monel, Inconel and Ni-Resist are used at low and moderate temperatures with dilute sulfuric acid. Nickel, Monel and Ni-Resist are most resistant when reducing conditions prevail and Inconel is more resistant under oxidizing conditions. These materials also tend to be cathodic to steel so that they will receive some protection in bimetallic systems when steel or cast iron are present.

Hastelloys and Chlorimets

These materials are used for handling sulfuric acid under conditions that are considered severe for most other materials of construction, such as high temperatures at high concentrations, high fluid velocities and where mild abrasives may be present.



Big new mine at Wilmington, Illinois, Typical of SOUTHERN'S completely modern processing plants.

LOWER STEAM COSTS?

Your Answer is APPLICATION OF THE *RIGHT* COAL to your SPECIFIC BURNING EQUIPMENT

YOU GET TECHNICAL HELP: SOUTHERN'S combustion engineers analyze your burning equipment. Fuel recommendation is made from America's most outstanding selection of engineered industrial coals. Burning tests in your own boilers **prove** most efficient application. Final result—you are confident that you have the ***right*** coal for LOWERING STEAM COSTS.

YOUR SUPPLY IS CONSTANT, DEPENDABLE: Big modern mines in Ohio, Indiana, Western Kentucky and Illinois, on twelve major railroads serve every Midwestern industrial area. Ten million tons annual producing capacity, backed by almost unlimited reserves.

YOU ARE ASSURED OF UNIFORM HIGH QUALITY: SOUTHERN'S engineered industrial coals are thoroughly washed, rinsed, blended and sized in preparation plants equipped with every modern coal processing facility. They are laboratory tested daily at the mine.

Let this most advanced Coal Service help you LOWER STEAM COSTS. Contact your nearest Southern office. We will gladly submit recommendations and proposals upon analysis of your requirements.

Southern Coal Company, Inc.

GENERAL OFFICE: 333 NORTH MICHIGAN AVENUE, CHICAGO 1, ILLINOIS
OFFICES IN: CHICAGO • LOUISVILLE • MEMPHIS • NASHVILLE • ST. LOUIS
Sinclair Coal Company, Kansas City 6, Missouri, Western Representative
Boon-Strachan Coal Company, Ltd., Montreal, Canadian Representative

3 special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in

ENGINEERED PLANT SERVICES

1. NEW EQUIPMENT

Begins on page 10

Contains highlights of new products by leading manufacturers, briefed and illustrated for your easy reference. Complete data on each of these products are available ***free.***

2. NEW BULLETINS

Begins on page 24

Includes descriptions of only those bulletins and catalogs that are really ***new*** and of ***direct value*** to you — saves your reading time, yet gives you full service. All bulletins sent to you ***free*** on request.

3. READERS GUIDE TO ADVERTISED PRODUCTS

Begins on page 135

Designed to catalog advertised products for your convenience in finding the ads which are of special interest to you at this time. Also lists those important bulletins, catalogs and working data offered ***free*** in the advertisements.

REQUEST CARD FOR LITERATURE OR MORE INFORMATION—Dec., 1951

To: INDUSTRY AND POWER, St. Joseph, Mich. Please have forwarded to me, at no obligation, the free literature I've indicated by the following key or paragraph numbers:

New Equipment begins Page 10	*New Bulletins begins Page 24*	*Advertised Products begins Page 135*
No.'s	No.'s	No.'s

Your Name _____ **Title** _____

Your Company _____

Co. Address (St. & No.) _____

City _____ **State** _____

Inquiries for items listed in this issue not serviced beyond Mar. 1, 1952

FIRST CLASS
PERMIT No. 19
(Sec. 34.9, P.L. & R.)
ST. JOSEPH, MICH.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

2¢—POSTAGE WILL BE PAID BY

INDUSTRY AND POWER
420 MAIN STREET
ST. JOSEPH, MICH.

3 *special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in*

ENGINEERED PLANT SERVICES

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Your Name _____ **Title** _____

Your Company _____

Co. Address (St. & No.) _____

City _____ **State** _____

Inquiries for items listed in this issue not serviced beyond Mar. 1, 1952

Readers' guide to advertised products

This department is both a product index for advertising and a keyed listing for advertised literature. List paragraph key numbers on reader service card to get data you want.

See Reader Service Card Page 133

ANTI-CORROSIVE & PROTECTIVE COATINGS

Rust Preventive **500**

Rust-Oleum seals metal so that no rust-causing oxygen can reach it. Available in full range of colors. Write for data. Rust-Oleum Corp. See page 61.

BOILERS & BOILER ACCESSORIES

Generators **501**

Write for descriptive literature on Wickes complete line of steam generating equipment or consult nearest Wickes representative. Wickes Boiler Co. See page 167.

Generators **502**

Write for Booklet 3B38A containing data on Erie City's complete steam power plant equipment. Erie City Iron Works. See page 112.

Water Gages **503**

New or already-installed Yarway Flat Glass Gages may be equipped with Illuminator that shines like a star. Write for Bulletins WG-1812, WG-1830 and WG-1822 describing complete Yarway water level system. Yarnall-Waring Co. See pages 12, 13.

Boilers **504**

See advertisement for information on Vertical Unit Boilers. Combustion Engineering—Superheater, Inc. See pages 104, 105.

Vane Control **505**

Write for Bulletin DB 92-810 for full information on power savings through the use of Vane Control. Westinghouse Electric Corp., Sturtevant Div. See page 59.

Steam Generating Units **506**

Bulletins with general information and showing typical installations of Vogt steam generating units are available upon request. Henry Vogt Machine Co. See page 54.

Boilers **507**

Kewanee heavy-duty firebox boilers are especially adapted for high pressure. Write for 6" scale with pipe diameter markings. Kewanee Boiler Corp. See page 150.

Generators **508**

See advertisement for information on Union steam generators. Consult with Union engineers for your boiler needs. Union Iron Works. See page 106.

BUILDING MATERIALS & MAINTENANCE

Pipe Joint Compound **509**

Write for free sample of Key pipe sealing compound that expands when heated, forming perfect seal. Assembled joints will not freeze in service. Key Company. See page 142.

Steel Grating **510**

See page 138 which lists 5 built-in advantages found in Blaw-Knox electro-forged steel grating. Write for Bulletin 2365. Blaw-Knox Div. of Blaw-Knox Co. See page 138.

Iron Cement **511**

Write for free 40-page repair handbook describing Smooth-On repairs that can save you time and money. 170 illustrations. Smooth-On Mfg. Co. See page 159.

Floor Patch **512**

Send coupon in ad for complete details of trial order plan and Handbook of Building Maintenance. Flexrock Co. See page 156.

COMPRESSORS

Compressors **513**

Write for complete facts concerning Cooper-Bessemer motor-driven compressors that offer you big savings. Up to 3000 hp range. The Cooper-Bessemer Corp. See page 108.

Compressors **514**

Send coupon in advertisement for Free Booklet C-50B with data on installing stationary air compressors. Schramm, Inc. See page 47.

Compressor **515**

Investigate the Fuller Rotary Compressor. Write for free Bulletin C-5 with complete information. Fuller Co. See page 58.

Compressors **516**

Write for Bulletin 728-8 with complete information on CP oil-less cylinder compressors. Chicago Pneumatic Tool Co. See page 125.

(Continued on page 136)

PRODUCT INDEX

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Mechanical Power Transmission 138

Packaged Steam Generators 138

Packing & Gaskets 139

Pipe & Fittings 139

Pumps 140

Refractories 140

Soot Blowers & Tube Cleaners 140

Steam Specialties 140

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Water Treatment 141

Welding & Cutting Equipment 142

Readers' guide to

advertised products

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CONTROLS, REGULATORS & INSTRUMENTS

Thermometers **517**

Write for literature describing Weston all-metal, as well as electrical and glass thermometers. Weston Electrical Instrument Corp. See page 139.

Tank Gage **518**

Write for complete details on automatic liquid level gages for measuring liquids of all kinds. The Liquidometer Corp. See page 159.

Hopper Level Switches **519**

Write for Catalog data on Syntron Hopper Level Switches. Syntron Co. See page 148.

Flow Indicators **520**

See advertisement for complete information on the Henszey Flow Indicators. Write for details. Henszey Co. See page 150.

Temperature Regulators **521**

Write for Stacon Bulletin 50-1000 for full details on extra sensitive, accurate, economical temperature regulators. Farris Stacon Corp. See page 164.

Regulators **522**

See advertisement for information on Type ED pressure regulators that assure accurate, dependable control with maximum money-saving performance. Spence Engineering Co., Inc. See page 46.

Temperature Control **523**

Automatic temperature and humidity control for heating, ventilating, air conditioning and process control. The Powers Regulator Co. See page 156.

Indicator & Recorder **524**

For a quick, dependable check on CO_2 content of flue gases, use Ranarex. Write for free booklet. The Permutit Company. See page 146.

Instruments **525**

Write for Bulletin 1-715 with data on Tempscribe recording thermometer. Bulletin 1-760 describes FloRite anemometer. Bacharach Industrial Instrument Co. See page 130.

Pressure Controllers **526**

See advertisement for information on Masoneilan No. 2700 Pressure Controllers. Mason-Neilan Regulator Co. See page 137.

Controls **527**

Write for Catalog 700 with complete data on Mercoid controls for heating, air conditioning, refrigeration and various industrial applications. Mercoid Corp. See page 164.

ELECTRICAL DISTRIBUTION

Sealtite Electrical Conduit **528**

See advertisement for information on Sealtite Electrical Conduit. For permanent or temporary wiring installations. The American Brass Co., American Metal Hose Branch. See page 7.

Mechanical Rectifiers **529**

Write for Bulletin 5106 with informative charts, diagrams and illustrations explaining the I-T-E Mechanical Rectifier's operation. I-T-E Circuit Breaker Co. See pages 18, 19.

Unit Substations **530**

Write for Catalog 9000 with complete information on all types of secondary unit substation equipment. I-T-E Circuit Breaker Co. See pages 118, 119.

Electrical Enclosures **531**

Write for catalog that shows many types of fabricated parts in various gauges and alloys. For no-cost, no-obligation estimate, send set of prints to The Kirk & Blum Mfg. Co. See page 66.

ELECTRIC HEATING UNITS

Heaters **532**

Send coupon in advertisement for catalog and complete data on Chromalox all-metal radiant heaters. Edwin L. Wiegand Co. See page 37.

ENGINES

Engines **533**

See advertisement for information on Dual Fuel Engines. Write for further data. Worthington Pump & Machinery Corp., Engine Div. See page 60.

Engines **534**

See advertisement for information on Troy steam engines. Write for Bulletin 306 with complete data. Troy Engine & Machine Co. See page 111.

FANS AND BLOWERS

Fans and Blowers **535**

Mail coupon on page 2 for complete information on Hartzell fans and blowers. Hartzell Propeller Fan Co. See page 2.

FUELS & FIRING EQUIPMENT

Coal **536**

See advertisement on page 129 for information on this product. General Coal Company. See page 129.

For your free copies of this new literature and more data on advertised products, list the key numbers of the descriptive paragraphs on one of the handy order cards on pg. 133. Mail today—postage-free!

When You Call For Any Industrial Requirement In Piping
ALBERT
"Rings the Bell"
SPEEDLAY PIPE SYSTEM—completely packaged for fast-laying temporary and semi-permanent lines for water, compressed air and other services.
PILING—Sheet Piling—light weight • Tubular—all sizes
PILE SHELLS—Spiral Welded, Hel-Cor, Riveted, CAISSONS
PILE FITTINGS—All types and sizes for steel and wood, cast steel and iron points. Plates and shoes cast steel and malleable iron sleeves.
CULVERTS—Corrugated, Spiral or Riveted Steel.
VALVES AND FITTINGS—Tube turns, Dresser, Vitaulic, cast iron or steel, forged steel, special alloys, water main.
SPECIALISTS IN PRE-FABRICATED PIPING
ALBERT
PIPE SUPPLY CO., INC.
Berry at North 13th St.
Brooklyn 11, N. Y.
Phone EVergreen 7-8100

Roto-Grate Stokers **537**

Write for free bulletins with complete information on the Detroit Roto-Grate Stoker. Other types and sizes for every industrial need also. Detroit Stoker Co. See page 4.

Fuel Oil Additive **538**

Mail coupon on page 153 for full information and free sample of Houghto-Solv that removes sludge from fuel oil. E. F. Houghton & Co. See page 153.

Coal **539**

If you have a coal problem, consult the Beacon Combustion Service Man for the type to fit your exact needs from the Beacon line of quality fuels. Eastern Gas & Fuel Associates. See page 57.

Oil Burners **540**

Send coupon on page 31 for complete data on Coppus-Dennis FANMIX Oil Burners. Coppus Engineering Corp. See page 31.

Stokers **541**

Send coupon on page 122 for further data and free heating analysis on commercial models of Combustioneer automatic coal stokers. Combustioneer, The Steel Products Engineering Co. See page 122.

Coal **542**

See page 132 for basic advantages of Southern's industrial coals. Write for profitable engineering counsel today. Southern Coal Co., Inc. See page 132.

Stokers **543**

Send coupon in advertisement for free copy of Perfect Spread Stoker booklet and new stoker report. American Engineering Co. See pages 40, 41.

Coal **544**

See advertisement for complete information on bituminous coal, the economical fuel for industrial use. Bituminous Coal Institute. See pages 8, 9.

Pulverizer **545**

See advertisement for information on the new Riley Pulverizer. Write for your free copy of "The Use Of Tungsten Carbide In Coal Pulverizers". Riley Stoker Corp. See pages 32, 33.

Burners **546**

Write for literature on the John Zink Series CBM, Y and YC combination gas and oil burners and ST gas burner. John Zink Co. See page 127.

(Continued on page 138)

For your free copies of this new literature and more data on advertised products, list the key numbers of the descriptive paragraphs on one of the handy order cards on pg. 133. Mail today—postage-free!

MASONEILAN MODEL 2700 PRESSURE CONTROLLER

Offers Accurate Proportional Control...
Precise Response...
Ease of Adjustment...

...YET IS MODERATELY PRICED

Masoneilan No. 2700 Pressure Controllers are especially designed for applications requiring accurate control when expensive instruments are not warranted. The pneumatic feedback, usually found only in more elaborate proportional controllers, assures precise response. The Control point setting mechanism provides accuracy of adjustment and easily read expanded index scale. Control action is reversible with either bourdon or bellows. The controllers are furnished in two case styles: a universal case for panel mounting; and a specially designed case for valve or wall surface mounting.

Applications include — pump governors, steam pressure reducing stations, gas well pressure reduction, and many others requiring small to intermediate proportional band.

MASONEILAN **MASON-NEILAN REGULATOR COMPANY**
1191 ADAMS STREET, BOSTON 24, MASSACHUSETTS, U. S. A.

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago St. Louis • Philadelphia • Houston • Denver • Pittsburgh • Cleveland • Cincinnati • Tulsa Atlanta • Los Angeles • San Francisco • Salt Lake City • El Paso • Boise • Albuquerque Detroit • Charlotte, N. C. Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

Readers' guide to advertised products

(Continued from page 137)

HEAT EXCHANGER EQUIPMENT

Heat Exchanger **547**

Write for Bulletin No. 11.0.080 with full details on the Pritchard Quintair Heat Exchanger. J. F. Pritchard & Co. See page 144.

Deaerators **548**

See advertisement for general information on tray and steam-jet deaerators. Worthington Pump & Machinery Corp., Steam Power Div. See page 55.

Freon Coolers **549**

Mail coupon on page 143 for PK Freon Cooler Catalog with complete data, tables, charts and data sheets. The Patterson-Kelly Co., Inc. See page 143.

Water Heaters **550**

Pick instantaneous water heaters are engineered to provide any volume of water at the temperature required. Write for details. Pick Mfg. Co. See page 154.

Cooling Towers **551**

Write for free technical articles: "Cooling Tower Studies," "Cooling Tower Maintenance," "Evaluating Cooling Tower Performance." The Fluor Corp., Ltd. See pages 22, 23.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Lubricant **552**

Send for illustrated booklet, "Sunoco Way Lubricant" with complete information and factual case histories. Sun Oil Co. See page 101.

Lubricant **553**

Write for complete information and free testing sample of "NR" grade Non-Fluid Oil for all pneumatic tools and equipment. New York & New Jersey Lubricant Co. See page 160.

Cylinder Lubrication **554**

Sinclair makes a wide variety of steam cylinder oils to handle every possible need. Write for further details. Sinclair Refining Co. See pages 44, 45.

For your free copies of this new literature and more data on advertised products, list the key numbers of the descriptive paragraphs on one of the handy order cards on pg. 133. Mail today—postage-free!

Lubricant **555**

Write today for case histories of savings made through the use of Lubriplate in your industry. Lubriplate Div., Fiske Bros. Refining Co. See page 130.

Lubrication **556**

Mail coupon on page 43 for free booklet "11 Ways to Cut Production Costs" and data on the new Alemite Oil-Mist System. Alemite, Div. of Stewart-Warner. See page 43.

Lubrication Service **557**

See advertisement for information on Standard's on-the-spot lubrication service and benefits gained for hydraulic operations with Stanoil. Standard Oil Co. (Indiana) See pages 35, 36.

MECHANICAL POWER TRANSMISSION

V-Belts **558**

See advertisement for typical examples of Goodrich Grommet Belts. The B. F. Goodrich Co., Industrial Products Div. See pages 49, 50, 51, & 52.

Conveyor Belts **559**

Consult the Goodyear Technical Man for your needs in conveyor belts and other industrial rubber products. Goodyear Tire & Rubber Co. See page 3.

PACKAGED STEAM GENERATORS

Generators **560**

Write for new fully illustrated Catalog 401 with complete details on Su-

CUT YOURSELF A KEYWAY

as easy as carving a slice off the bird

DO IT QUICK — any width keyway from ⅛" to 1", in any bore from ¼" to 3" in SIXTY SECONDS.

DO IT CHEAP — with the "Minute Man" Broach you cut keyways for as little as a penny apiece, instead of the dollars it takes on a big machine tool.

DO 'EM ALL — du Mont makes 21 standard sets; 23 standard sizes of broaches, 59 standard size bushings, and a wide range of special production type guideless broaches.

MAIL THIS COUPON FOR INFO AND PRICES

The du MONT CORPORATION, Greenfield, Mass.

Please mail descriptive folder and price list I on *Minute Man Keyway Broaches and Kits.*

Name.....

Company.....

Address.....

See us at Booth 5216—3rd Plant Maintenance Show—Philadelphia, January 14-17.

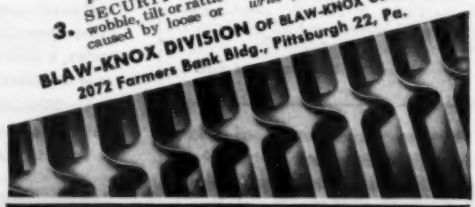
SAFE • STRONG • SECURE

Before specifying or purchasing open steel flooring check these exclusive features of Blaw-Knox Grating...

1. SAFETY underfoot at all times assured by twisted steel cross bars.
2. STRENGTH that only rigid "one-piece" Electroforged construction can provide.
3. SECURITY—no wobble, tilt or rattle caused by loose or lost screws, nuts, bolts.
4. EASY to maintain and paint . . . no sharp corners to clog with dirt.
5. MAXIMUM open area for light and air.

For complete data on Blaw-Knox Electroforged Steel Grating and Stair Treads write for Bulletin 2365.

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2072 Farmers Bank Bldg., Pittsburgh 22, Pa.



BLAW-KNOX *Electroforged*
STEEL GRATING & STAIR TREADS

perior Steam Generators available in 18 sizes. Superior Combustion Industries Inc. See page 17.

Generators **561**

Mail coupon on page 30 for catalog and desk demonstration of Clayton Forced Recirculation Steam Generators. Clayton Mfg. Co. See page 30.

Generators **562**

Write for Bulletin EC-100 with complete information on Dutton Econotherm "packaged" steam generators. Dutton Boiler Div., Hapman-Dutton Co. See page 155.

Generators **563**

Write for Catalog PG-51-2 with complete information on the Foster Wheeler Package Steam Generator. Foster Wheeler Corp. See pages 26, 27.

PACKINGS & GASKETS

Packings **564**

Write for catalog with full information on the complete line of "John Crane" packings. Crane Packing Co. See page 117.

Packings **565**

See advertisement on page 148 for information on Durametallic Packings. Submit your sealing problems for free counsel. Durametallic Corp. See page 148.

Packings **566**

Write for complete information on Johns-Manville asbestos sheet packing for a tight, long-lasting seal. Johns-Manville. See page 162.

PIPE AND FITTINGS

Industrial Hose **567**

For water, foam, chemical or booster service — wrapped, jacketed, rubber-covered or molded-and-braided. Hewitt-Robins. See page 147.

Pipe Unions **568**

See advertisement for information on Dart Unions. Write for full details. Dart Union Company. See page 141.

Piping **569**

See advertisement for information on Grinnell piping. Grinnell Co., Inc. See page 121.

Flexible Metallic Tubing **570**

Write for your copy of "Flexineering" with latest data on the application of flexible tubing for the greatest efficiency. Pennsylvania Flexible Metallic Tubing Co. See page 39.

(Continued on page 140)

For your free copies of this new literature and more data on advertised products, list the key numbers of the descriptive paragraphs on one of the handy order cards on pg. 133. Mail today—postage-free!

WESTON *Readable* ALL-METAL THERMOMETERS

—AVAILABLE IN THESE 3 TYPES

STANDARD INDUSTRIAL THERMOMETERS

All-metal dial types with stainless steel stems, in straight and angle forms. Scale lengths 3"–6" and 9", with stems from 2½" to 72". Available as testing thermometers, and for general purpose and heavy duty service. Ranges from −100 to +1000°F. All-metal construction prevents breakage, assures dependable accuracy for longer periods.

CONTACT MAKING THERMOMETERS

Combines the features of the all-metal indicating thermometer with an alarm or control device. Has adjustable contact arm mounted in the glass and bezel. Supplied to make contact on increasing or decreasing temperatures. Has positive magnetic type contacts. Contact rating . . . 100 ma at 110 volts a-c; 50 ma at 110 volts d-c. Stem lengths 2½" to 24".

MAX-MIN THERMOMETERS

Equipped with a manually set red index which moves up or down scale with pointer, remaining at extreme temperature reached until reset. Thus one reading gives present temperature, and maximum or minimum reached since last reading. Available in scale lengths of 6" and 9"—stem lengths 2½" to 24".

Literature describing Weston all-metal, as well as electrical and glass thermometers, sent on request. WESTON Electrical Instrument Corporation, 605 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

WESTON *Instruments*

Readers' guide to

advertised products

(Continued from page 139)

Flexible Metal Hose **571**

Write for literature with full information on CMH Flexible Metal Hose. In all types of connections — for every metal hose requirement. Chicago Metal Hose Corp. See page 62.

Air and Water Hose **572**

An inquiry will bring you full particulars on Republic's complete line of hose, belting, packing and molded & extruded products. Republic Rubber Div., Lee Rubber & Tire Corp. See page 29.

Pre-Fabricated Piping **573**

One convenient source for any industrial requirement in piping. Write for data. Albert Pipe Supply Co., Inc. See page 136.

Swivel Joints **574**

Write for Catalog No. 50-C that gives full data on more than 500 different types, styles and sizes Chiksan Ball-Bearing Swivel Joints. Chiksan Co. See page 157.

PUMPS

Pumps **575**

Consult the Weinman centrifugal specialist for complete information on Weinman pumps that assure uninterrupted service. The Weinman Pump Mfg. Co. See page 123.

Pumps **576**

Write for Bulletin 105-M for complete details on the Aurora Type-OD centrifugal pump. Aurora Pump Co. See page 142.

Controlled Volume Pumps **577**

Packaged systems are custom engineered. All necessary accessory equipment supplied. Write for complete information. Milton Roy Co. See page 34.

Pumps **578**

Marlow specializes in manufacturing pumps for handling difficult industrial wastes. Send coupon for complete information. Marlow Pumps. See page 126.

REFRACTORIES

Insulating Cement **579**

Advertisement lists 7 reasons for using Stic-Tite plastic insulation. Send coupon for bulletin and free sample. Refractory & Insulation Corp. See page 65.

SOOT BLOWERS & TUBE CLEANERS

Tube Cleaners & Expanders **580**

Check your boiler room maintenance equipment needs for Airetool boiler tube cleaners, expanders and accessory tools. Write The Airetool Mfg. Co. See page 151.

Soot Blowers **581**

See advertisement on page 25 for information on Diamond Soot Blowers. Diamond Power Specialty Corp. See page 25.

STEAM SPECIALTIES

Traps **582**

Write for free 24-page book with complete information on Yarway Impulse Steam Traps. Yarnall-Waring Co. See page 68.

Traps **583**

See advertisement on page 64 for information on Sarco balanced pressure thermostatic steam traps. Write for details. Sarco Company, Inc. See page 64.

Traps **584**

Write for your copy of Catalog 68-J on the complete Strong steam specialties line. Strong, Carlisle & Hammond Co. See page 152.

Traps **585**

Write for literature on Crane steam traps for outstanding service on heavy-duty steam drying units. Crane Co. See page 42.

Fluid Controls **586**

Write for bulletins on the Illinois line of automatic equipment to control steam from boiler outlet to return inlet. Illinois Engineering Co. See page 165.

Traps **587**

Write for your free copy of the 36-page book on Solving Steam Trap Problems. The V. D. Anderson Co. See page 168.

TOOLS

Blower Suction Cleaner **588**

Write for complete information on the Clements-Cadillac portable blower-suction cleaner. 5 Models with complete attachments. Clements Mfg. Co. See page 128.

Keyway Cutter **589**

Mail coupon on page 138 for descriptive folder and price list on Minute Man Keyway Broaches and Kits. The du Mont Corp. See page 138.

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4 WAYS TO CUT THOSE PUMP REPAIRS

Sims valves are made in sizes from 1¾" to 15¼" to fit any reciprocating pump. Valves supplied ready to install—cast in individual units or in complete plates.

1. **Prevent STEM and SPRING breakage.** Exclusive double shock absorber built into Sims valves stops impact shock.
2. **Stop wear.** Long guide of ROTATOR prevents cocking of DISC—assures even opening.
3. **Keep seating surfaces leak free.** Only Sims guarantees the valve DISC will rotate every time it lifts.
4. **Stop valve slam and knock.** Quiet operation is gained by cushioning moving parts and cutting resistance to flow through the SEAT ... with patented inclined ribs. This reduction of resistance allows cylinders to fill completely. Pump capacity is increased 20%.

SIMS PUMP VALVE CO., INC.

New catalog shows how Sims valves fit any pump—how they work—efficiency and comparison charts. Send for your free copy today.

145 HUDSON ST., NEW YORK 13, N. Y. • M & M BLDG., HOUSTON, TEXAS

TURBINES

Turbines **590**

General information on steam turbines. Worthington Pump & Machinery Corp., Steam Turbine Div. See page 53.

Turbines **591**

Write for bulletin with complete information on the Terry Solid-Wheel Turbine. The Terry Steam Turbine Co. See page 38.

VALVES

Valves **592**

Write for Bulletin No. 30 with complete information on Chapman Tilting-Disc Check Valves. The Chapman Valve Mfg. Co. See page 166.

Valves **593**

See advertisement that lists 4 ways to cut pump repairs with Sims valves. Send for free catalog. Sims Pump Valve Co., Inc. See page 140.

Check Valves **594**

Write for Bulletin WH-100 with complete information on Williams-Hager flanged silent check valves. The Williams Gauge Co. See page 131.

Diaphragm Valves **595**

Write for literature describing Hills-McCanna diaphragm valves with L-1 plastic diaphragm. Hills-McCanna Co. See page 145.

Valves **596**

Write for Edward Catalog 12-G6 with complete information describing Univalves and Intex valves. Edward Valves, Inc. See page 15.

Valves **597**

See advertisement with information on Fairbanks valves for outstanding design, sound engineering and rugged construction. The Fairbanks Co. See page 149.

Valves **598**

The W. S. Rockwell Valve News describes latest developments in control valves for air, gases, liquids & semi-solids. Write to receive copies monthly. W. S. Rockwell Co. See page 158.

WATER TREATMENT

Water Treatment **599**

Write for new descriptive Bulletin 512 with complete technical data on the Elgin DeIonizer. Elgin Softener Corp. See page 21.

(Continued on page 142)

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Yes, you can use a DART
Over and Over Again
and it still stays tight!

When you buy a Dart Union you're truly driving a *tight* bargain!

Because Darts can be used over and over again you get a bonus in extra service — for years.

Because they tighten easily — and *stay drop tight,* installation is easier and nuisance maintenance and unnecessary service calls are avoided. You can thank the heavier construction of a Dart and spherical grinding to a *true* ball joint for this.

Because body and nut are made of practically indestructible, air-refined malleable iron, and bronze is used for both seats — the outside withstands abusive wrenching and stress, the inside, corrosion and pitting.

Just try *one* Dart and you'll be sure to go *100%* Dart! You'll notice the *difference!*

DART UNION COMPANY
Providence 5, Rhode Island
The Fairbanks Co.—Distributors
Boston New York Pittsburgh

DART
UNIONS

Readers' guide to

advertised products

(Continued from page 141)

Water Treatment **600**

Check into the advantages that can be yours through the Nalco Service Agreement. Write for complete details. National Aluminate Corp. See page 11.

Water Conditioning **601**

See advertisement for general information on Worthington Hot-Z deaerating type water conditioning system. Worthington Pump & Machy. Corp., Water Treating Section. See page 56.

Industrial Water Treatment **602**

Mail coupon on page 63 for bulletins on Dearborn improved Polyamide Anti-Foams and Industrial Water Treatment, or ask for a Dearborn engineer to call. Dearborn Chemical Co. See page 63.

Boiler Water Comparator **603**

Write for free copy of "Modern pH and Chlorine Control". Gives theory and practice of modern boiler water testing, also complete data on Taylor equipment. W. A. Taylor and Co. See page 6.

Water Treatment **604**

Write for Bulletin DM with complete details on H & T's ion exchange Demineralizing Units. Process insures purest water. Hungerford & Terry, Inc. See page 128.

Water Treatment **605**

Graver manufactures every type of water treating equipment. Send sample of your raw water supply for free analysis. Graver Water Conditioning Co. See page 67.

Water Treatment **606**

Send for new illustrated Drew Organics Folder describing use of organics in modern boiler water treatment. E. F. Drew & Co. See page 115.

WELDING & CUTTING EQUIPMENT

Gas Tanks **607**

Write for address of nearest Prest-O-Lite Gas Service Station that can supply new tanks or exchange full tanks for your empties. Linde Air Products Co., Div. of Union Carbide & Carbon Corp. See page 48.

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READERS' GUIDE

See page 135 for classified list of literature offered by advertisers.

You'll find it so convenient to use one of the postcards on page 133 for requesting literature or more information about advertised products. Just list the paragraph key numbers for material you want and drop the card in your OUT basket. Your inquiry will be processed quickly and accurately.

PROTECT Your Oil or Steam Lines Against Leaky Joints with

KEY GRAPHITE PASTE

Thread and gasket connections on oil lines . . . either hot or cold . . . or high pressure steam lines . . . will not leak when sealed with Key Graphite Paste.

This sealing compound expands when it is heated, forming a perfect seal. Assembled joints will not freeze in service. Key preserves threads and gaskets and, above all, it is economical to use because it goes several times further than ordinary pipe dopes.

Ask your jobber for Key Graphite Paste or take advantage of our FREE sample offer.

Send For FREE SAMPLE

Try Key Graphite Paste at our expense

KEY Company

KEY COMPANY

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There is a PUMP by Aurora for every pump job.
TYPE-OD
Aurora Horizontally Split-Case, Double Suction, Single Stage Centrifugal Pump.
For general water supply for municipalities, industries, office buildings, institutions—also—for handling liquids, chemical solutions, oils etc., in a wide variety of industries. Write for Bulletin 105-M for further details.

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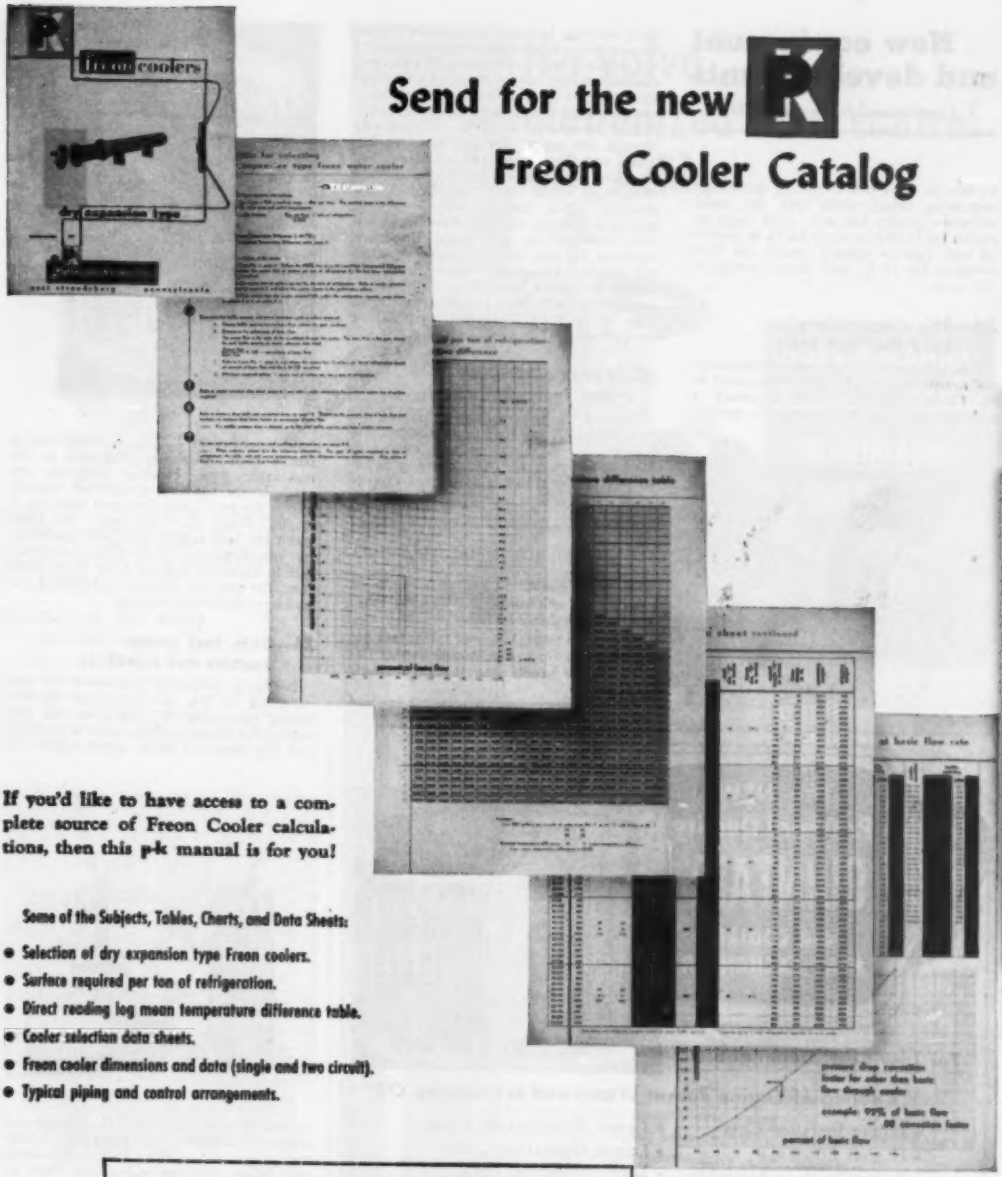
AURORA Always PUMPS

AURORA PUMP COMPANY

42 Loucks Street, Aurora, Illinois

Send for the new p-k Freon Cooler Catalog



If you'd like to have access to a complete source of Freon Cooler calculations, then this p-k manual is for you!

Some of the Subjects, Tables, Charts, and Data Sheets:

- Selection of dry expansion type Freon coolers.
- Surface required per ton of refrigeration.
- Direct reading log mean temperature difference table.
- Cooler selection data sheets.
- Freon cooler dimensions and data (single and two circuit).
- Typical piping and control arrangements.

Gentlemen: Please send p-k Catalog 101

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

The Patterson-Kelly Co., Inc.
133 Burson St., E. Stroudsburg, Penna.

Available in 1, 2, 3-circuit construction

1109

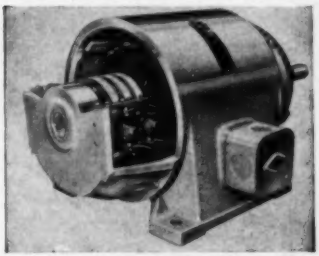
New equipment and developments

(Continued from page 20)

trically for three-pole switching duty. High momentary rating—6500 amp rms asymmetrical—permits use with extra large capacitor banks and capacitor banks in parallel on high capacity systems. Switch has been designed for 15 kv and thermal rating of 200 amp.

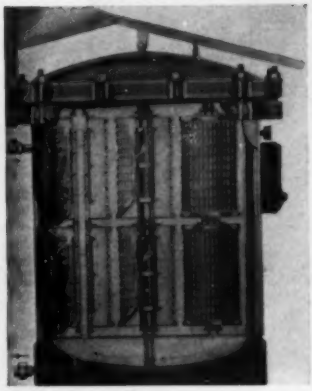
24—Slip ring motors have flat end bells

Slip ring motors featuring compactness and mounting adaptability are announced by the Reuland Electric Co. Arrangement of collector rings and brush assembly permits their complete housing in the motor's regular end bell. This eliminates protrusion of the assembly and reduces overall and other essential dimensions to those of a standard squirrel cage motor. Increased protection against arcing and flashing is also afforded. Added mounting versatility is provided through the use of flat end bells, so that brakes and other equipment can be attached on either end using face or flange type mountings. Units can be mounted in any position. Other features include shorter bearing-to-bearing spacing, superior wound rotor construction, and larger inspection openings for easy access to collector rings and brushes. The motors are available separately in ratings from ¾ to 15 hp or, in conjunction with gear reducers, in ratings from ¾ to 5 hp, in either drip-proof or totally enclosed construction.



25—Filter cartridges are interchangeable

Hilliard Corp. announces a line of improved type Hilco Hyflow lubricating and fuel oil filters. Units include swing-bolt head construction for quick opening of filter covers and a lifting device for ease of handling the cover. Filters are available using factory-made throwaway cartridges or the repackable type. Filtering materials are available for handling straight-run mineral oils or the heavy duty detergent type oils, a feature being that all types of filter cartridges, both factory-made and repackable, are interchangeable. Hilco filters are available in capacities ranging from ½ to 1000 gpm, for fuel oil filtering, lubricating oil bypass, or full-flow filtering.



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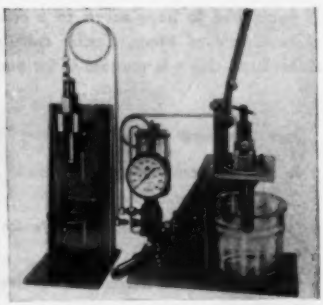
26—Sets test many nozzles and injectors

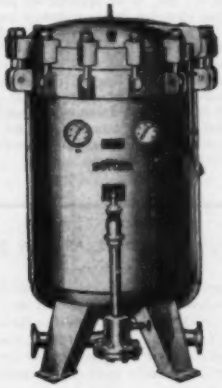
Bacharach Industrial Instrument Co. has expanded its line of nozzle and injector testing equipment to include several sets suitable for testing injection units of medium and large bore and stroke diesel engines. A typical set comprises specially-developed and simplified fixtures, the Bacharach nozzle test pump, and suitable fuel line connectors. Many different makes and sizes of heavy duty diesel nozzles and injectors can be tested.



27—Dehydrator reduces carbon in diesel fuel

Increased combustion efficiency, reduced carbon formation and less corrosion of working parts are claimed for internal combustion engines when using fuel dehydrated by a dehydrator developed by Bowser, Inc. Dehydration is accomplished by passing the fuel through elements, which are a combination of wound cellulose cylinders, specially treated coalescing media, perforated metal

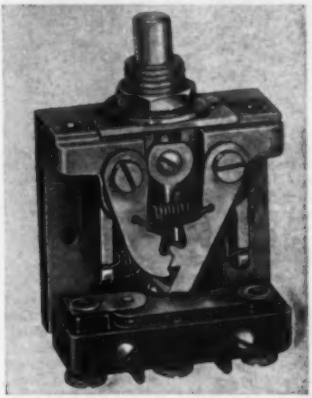
and glass cloth. There are no moving parts and with reasonable care the dehydrating elements will function indefinitely. Where there is a possibility of large volumes of water in fuel, a hydraulically balanced, auto-



matic ejector is available as an accessory. Available in capacities of 350 and 600 gpm. Maximum working pressure 125 psi. Shell and cover are heavy-gauge steel, ASME code labeled construction.

28—Switch has many applications

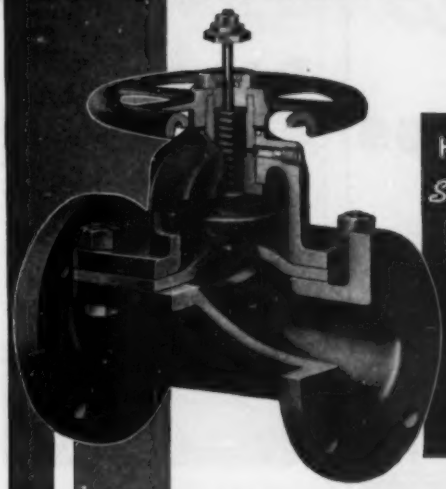
General Control Co. has developed for industrial use a maintained-position switch known as the type A-C-O. Typical applications for this alternate-contact-operating switch are circuit transfer of timers and recording equipment, in safety circuits and as



a limit switch. In operation the first press transfers the contacts, and the second press restores them. S.P.D.T. contacts permit adaptation of this switch to either normally closed or normally open circuits. Unusually fast switching is permitted by the return-action design of the operating plunger mechanism, which is insulated from the contacts. Mounting is either single hole mounting by means of a ½ in. threaded bushing, or top or side panel mounting with clearance holes for 6-32 screws. Overall di-

(Continued on page 146)

...here is the valve that revolutionized flow control of Sulphuric Acid...



HILLS-McCANNA
Saunders Patent
DIAPHRAGM
VALVE
with L-1
PLASTIC
DIAPHRAGM

Sulphuric acid up to 66° Bé can now be valved without leakage, clogging or sticking . . . with Hills-McCanna Diaphragm Valves equipped with the new L-1 plastic diaphragms. This new development combines the tried and proved Saunders Patent pinch clamp principle with a diaphragm of a special type of plastic that is particularly resistant to concentrated sulphuric acid.

Hills-McCanna Diaphragm Valves with L-1 diaphragms are suitable for temperatures up to 125° F. and pressures up to 100 psi. Sizes from ½" thru 4" are available, handwheel operated, quick opening (lever operated) and sliding stem models. Choice of nearly 50 body materials or linings including cast iron, cast steel, Tarimet or glass lined.

Literature is available describing Hills-McCanna Valves with data on their use for acid and other services. Write for your copy outlining the nature of your application. HILLS-McCANNA COMPANY, 2355 W. Nelson St., Chicago 18, Ill.

The valve illustrated in cut-a-way above is the Hills-McCanna Model 4800 semi-sealed bonnet acid valve with L-1 plastic diaphragm and tell-tale travel stop indicator. Valves of this type can be furnished where particularly rigid safety precautions must be taken.

HILLS-McCANNA CO.
saunders patent
diaphragm valves
Also manufacturers of — Proportioning Pumps
Force-Feed Lubricators • Magnesium Alloy Castings

Up-to-the-minute

CO_2

READINGS

with the RANAREX INDICATOR AND RECORDER

can save 10%

OR MORE OF YOUR FUEL DOLLARS

For a quick, dependable check on CO_2 content of flue gases, use RANAREX! It's a sure check that is accurate to within 3/10 of 1% of CO_2. Ranarex uses no chemicals, is sturdily constructed and easily maintained.

Get the *free* Ranarex booklet by writing to The Permutit Company, Dept. IP12, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.

RANAREX

PRODUCT OF PERMUTIT

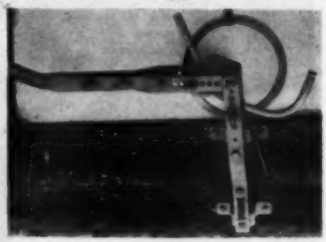
New equipment and developments

(Continued from page 145)

mensions are 2 in. wide by 2-25/32 in. high including plunger by 1-3/32 in. deep. A cover encloses the mechanical parts. Contacts are rated 20 amp, 125 v a-c, non-inductive.

29—Bender handles thin wall conduit

A bending die that adapts the Hossfeld No. 2 Universal iron bender to bending of thin wall electrical metal conduit has been announced by the Hossfeld Mfg. Co. With these dies, the bender makes round, smooth, wrinkle-free bends of all standard sizes of



thin wall conduit from ½ to 2 in. Full 90 deg bends in conduits of 1-1/4 in. size or smaller are made by direct leverage with one of the hand lever. A compound leverage principle makes bending of 1-½ and 2 in. conduit easy. Conduit is supported from the outside against flattening and wrinkling, no inside mandrel is needed. Other standard equipment for bending rod, bar, flat stock or angle iron may be added.

30—Training carrier corrects belt travel

Belt training carrier announced by Stephens-Adamson Mfg. Co. corrects conveyer belt shifts when installed on most applications at iatervals of 50 to 100 ft. Training rollers respond instantaneously to belt

shift and tilt the carrier so belt returns to center, whereupon carrier resumes its normal position. Edge wear of belt is said to be negligible with this carrier.

31—Device measures low level potential

Potentiometer circuit that permits measurements of spans as narrow as 100 mv has been developed by Brown Instruments Div. of Minneapolis-Honeywell Regulator Co. These narrow span instruments can be used wherever accurate measurements of d-c potentials of the order of microvolts is required. They are applicable for laboratory investigations and for production line measurements of low potential signals in the order of 0.1 mv. With appropriate primary measuring elements the instruments are also useful for precise measurement of differential temperatures. They are available with precision indicators or with either circular or strip chart type recorders. For control of the measured variable, the circular chart style of narrow span instrument should be employed, with a pneumatic control unit for actuating a diaphragm motor valve or other final control element.

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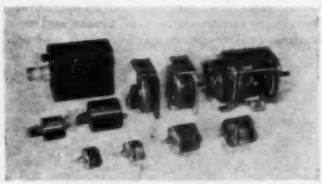
32—Transformers for 400-800 cycle duty

A line of Powerstat variable transformers for duty at frequencies of 400 to 800 c is offered by Superior Electric Co. Available in many voltage and current ratings, and in



single and polyphase models, these high cycle units are built to specific requirements to suit the application involved. Development of this equipment has been necessitated by recent advances in electrical apparatus.

33—Load selector aids beam users

A handy, pocket-size beam load selector has been devised by Unistrut Products Co. for those who specify or use Unistrut metal framing, to quickly determine the amount of weight which can be supported by various sections under varying conditions of span and unbraced height. Selector also accurately determines number of sections required to support a given load.

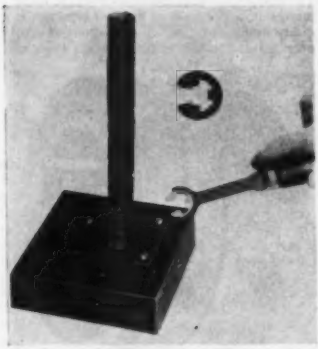
34—Floor surfacing has long life

Developed by Flexrock Co. to resist such common floor disintegrators as acid, water, oil and grease, AWOG floors are reported to outlast ordinary concrete by 3 to 1. The extreme durability is attributed to its tight, close-knit composition, which liquids cannot penetrate to attack the bonding element. Used for repairing broken areas or for complete overlays, AWOG sets up a smooth,

case-hardened, dustless surface that withstands grueling loads, steel wheels and hard blows. Sanitary and easily cleaned, it is recommended for new floors, for overlays over brick, stone or wood, and for repairing areas of any size, indoors or out.

35—Retaining rings dispensed singly

Individual dispensing and application are featured in stacked open-type retaining rings manufactured by Industrial Retaining Ring Co. Ring stacks cut to a fraction the time and motions ordinarily involved in selecting, untangling and applying retaining rings. A specially designed base holds the



ring stack erect. The rings are readily dispensed and applied with one hand and with one continuous motion using the industrial apolication tool. Made from carbon spring steel, the open-type rings provide shoulders on grooved circular shafts. They are designed to support heavy thrust loads and to withstand vibrations without displacement. They can be re-used without loss of resiliency.

36—Caulking compound remains pliable

Caulking compound that stays pliable over extended periods of time is announced by Samuel Moore Chemical Co. Known as Rub-Bub Chromated Caulk, the material was developed for use around joints, frames, sills, chimneys and other places subject to rust or decay. It offers protection indefinitely against the entrance of moisture, dirt, dust, insects or corrosive atmospheres. It is claimed that the compound is especially suitable for use on parts between which movement is possible. It has high adhesive and cohesive properties and is completely insoluble. Furnished in various consistencies for use with gun, brush or knife, it skins over quickly and can be painted in approximately 30 min.

37—Dust collector exhausts outside

A Dustkop dust collector designed for outdoor exhaust of air that has been cleaned of industrial dust, but still contains toxic fumes, is now available for use on 25 c power, according to announcement by Aget-Detroit Co. Capacity of this standard unit, model 20ND30, is 2450 cfm on a single 6

(Continued on page 148)

STILL BEST AT BLAZES

Until 1872, fire hose deteriorated faster in storage than when battling blazes. Then Hewitt-Robins perfected a hose whose tough fabric plies were chemically impregnated (*or carbolized*) against mildew and dry rot, mortal enemies of conventional hose.

It was called Maltese Cross® Fire Hose. The Maltese Cross made today is still unequaled for long life and unfailing performance. No Maltese Cross Fire Hose has ever burst at a fire; some installations are still in service after forty-five years.

The carbolizing process is a Hewitt-Robins "first"—one of many Hewitt-Robins contributions to industrial hose life and efficiency.

Today, among our 1000-plus types of natural and synthetic rubber hose, there are custom-designed fire hoses for industrial, municipal and marine fire protection . . . for water, foam, chemical or booster service. Whether wrapped, jacketed, rubber-covered or molded-and-braided, each reflects almost a century of hose-building experience . . . *each is right for the job.*

For fire hose . . . *for industrial hose of any kind* . . . get in touch with Hewitt-Robins.

HEWITT HR ROBINS

Executive Offices: 370 Lexington Avenue, New York 17, N. Y.

HEWITT RUBBER DIVISION: Belting, hose and other industrial rubber products
ROBINS CONVEYORS DIVISION: Conveying, screening, sizing, processing and dewatering machinery
ROBINS ENGINEERS DIVISION: Designing and engineering of materials handling systems

Hewitt-Robins is participating in the management and financing of Kentucky Synthetic Rubber Corporation

New equipment and developments

(Continued from page 147)

in. inlet, with a 4.5 in. static suction. Size of outlet for discharge of cleaned air to atmosphere is 8 in. Floor space required is 22 x 40 in. Overall height is 78 in. The unit is recommended for almost any type of industrial dust and is available from stock with motor for operation on either 220 or 440 v, 3 ph, 25 c power. Motors for operation on other power supply can also be obtained.

38—Feed-in duct easy to install

In order to substantially reduce installation time and effort, the Square D Co. has redesigned the joint in their Feed-in duct.

Matching left and right hand duct ends is now unnecessary as all ends are identical in construction. Factory installed joint bolts face outward for accessibility, and only tie plates and nuts are needed to complete the joint. Installation can be accomplished with one hand. Other features include: extremely low voltage drop, totally enclosed construction, balanced voltage drop and high mechanical and dielectric strength. The device is available in capacities of 600 to 4000 amp.

39—Hose satisfies many requirements

Multi-purpose, industrial type hose known as Abrasoflex, which is both oil and abrasion resistant, is announced by Mercer Rubber Corp. It can be used for any of eight industrial applications including air, welding, cold or hot water, paint or oil spraying, grease and gasoline. The hose is not only resistant to petroleum and its by-products but also to the mild acids found in water. Smooth bore permits uninterrupted, fast flow even though reeled, and the high-tensile, braided rayon body is designed for increased working pressures and to withstand normal abrasion of the body. Use of this hose can cut inventory requirements. It is available with a black cover with 1- or 2-braid high-tensile reinforcement in 7 sizes ranging from 3/16 to 1 in. ID, suitable for working pressures to 250 psi.

TO REQUEST ADDITIONAL FREE DATA

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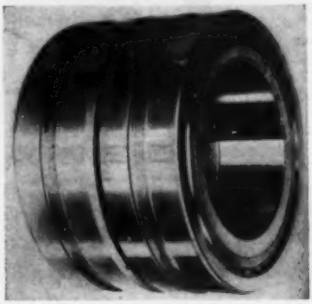
40—Anti-friction bearings handle severe loads

Tyson Bearing Corp. have added to their standard line of full roll type tapered antifriction one, two and four-row bearings. Single row bearings are available in sizes from 2 to 20 in. OD, two-row bearings from 4 to 20 in. OD and four-row bearings from 6 to 20 in. OD. These full-roll units have been engineered for use in gear drives, cranes and other heavy metal-working machinery. These tapered roller bearings provide maximum number of rolls of greatest capacity, rigidity and service life. Distribution of load over a full complement of tapered rolls as-



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No Spillage— No Shortage of Materials in Bins and Hoppers with—

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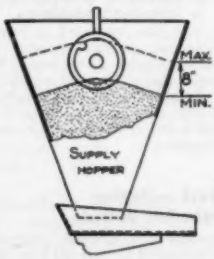
Hopper Level Switches



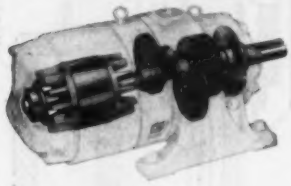
Write for Catalog Data

SYNTRON CO.
425 Lexington Ave. Homer City, Pa.

sures smooth operation at full radial and thrust capacities. Positive alignment is achieved by contact of the tapered rolls with the high back rib, which is an integral part of the cone.

41—Gear motor contains two secondary pinions

Geared motors have been developed by U. S. Electrical Motors, Inc. by using two secondary pinions to drive the output gear to double the effective torque rating of a



conventional single pinion and gear unit. Incorporating the use of a splined herringbone pinion to equally divide the load between the two secondary pinions, the type GL Syncrogear produces high torque at low speeds while occupying only a fraction of space required of a conventional drive. Available with ratings of 5 to 25 hp and with speeds from 30 to 84 rpm. The unit features asbestos-protected windings, normalized castings, solid centri-cast rotors and Lubriflush lubrication.

42—Tank preheater for 14½ in. manhole

A preheater for 14½ in. manholes of bulk storage tanks is being manufactured by Rempe Co., that has an all steel shell and coil assembly. This unit is for preheating oil and other liquids before they enter a suction line. The preheater rests on the bottom of the tank. Suction and inlet and outlet pipes—either steam or hot water—

go through the manhole cover. Flow accumulator causes the liquid to flow over heated pipes before entering the suction line. In this way liquids are heated to proper flow temperature and load is taken off the suction pump. Proper length inlet and outlet pipes to fit any diameter tank are furnished. The unit is tested with 400 psi air pressure under water after fabrication.

43—Variable speed drive comes in 2:1 to 6:1 range

A variable speed motordrive is announced by Reeves Pulley Co. that is designated as model No. 8000. This unit has a capacity of 25 hp and is available in all speed ranges from 2:1 to 6:1. No. 8000 is a complete, self-contained variable speed power plant. The user has the choice of any standard constant speed motor, and a built-in helical gear reducer when low output speeds are required. The model is offered in horizontal

(Continued on page 150)

If you pipe it...there's a
Fairbanks valve
to control it

Here are two typical examples of the outstanding design, sound engineering and rugged construction that are built into every Fairbanks Valve. Years of experience in meeting all kinds of valve requirements for industry, have given Fairbanks Engineers a storehouse of knowledge in controlling the flow of water, steam, gas, oil, chemicals, etc. Consult them without obligation.

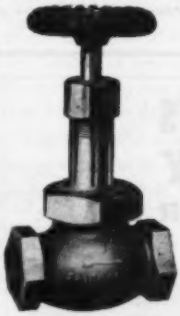


Fig. U-61
Renewable Composition Disc
Globe Valve — 150 lb. S.W.P.

Fig. 0236
UNION BONNET
— Renewable
Nickel Alloy Seat
Gate Valve —
200 lb. S.W.P.

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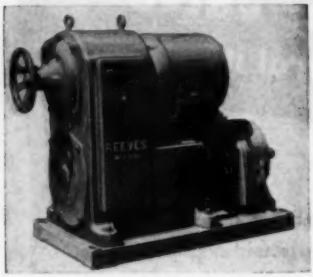
VALVES
DART & PIC UNIONS · TRUCKS · CASTERS

New equipment and developments

(Continued from page 149)



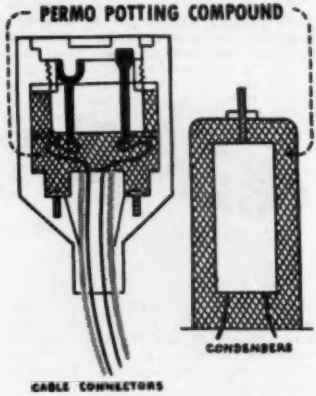
and vertical designs. Handwheel control is standard, but electrical or completely automatic hydraulic controls are also available.

44—Splice equalizes cable loads

Method of splicing steel cable conveyer belting, developed and patented by The B. F. Goodrich Co., places all cables under equal tension during vulcanization so that each cable carries its share of the load in the finished splice. The method also permits the straightest possible splice, resulting in belts that track straight and true. Laboratory stress-strain tests prove that the splice is as strong as anywhere else in the belt. To make the splice, cable ends are cut in staggered pattern. Small tubular connectors are placed over the butted ends. Connectors are first given a light crimping. The partially made splice is then stressed to even the lengths of the cables. Rubber and fabric removed for the splice is then rebuilt around the cables. The splice is cured under tension with a conventional vulcanizer. The tensioned splice can be made in the field as well as at the factory. Only special tools needed are a crimping device for squeezing the connectors to anchor the cable ends and a special scraping tool to remove rubber from the cables.

45—Sealing compounds resist high voltage and moisture

Sealing compounds—especially designed for use where high electrical insulation and low moisture transmission are required—are now available from H. V. Hardman Co., Inc. Known as Permo potting and sealing compounds, these products have found a wide variety af applications in fields where specifications are highly exacting. They are recommended for high electrical resistance where retention of viscosity over wide temperature ranges is necessary. These compounds are said to be ideal for the casting and sealing of electronic parts, batteries, transformers, coils, condensers and many types of electrical parts.



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46—Rectifier stacks in welder air cooled

Heavy duty direct current welding machine, put on the market by the A. O. Smith Corp., is designed for all industrial

Only 3 **MOVING PARTS** *in the* **HENSZEY**

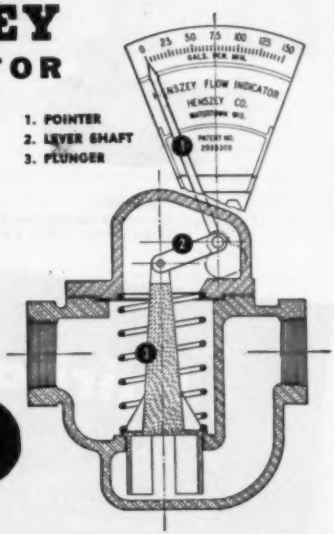
FLOW INDICATOR

There are only three moving parts in the Henszey Flow Indicator—the Pointer, the Lever Shaft and the Plunger. And that means longer wear, continued service, and constant accuracy.

The liquid enters the indicator below the plunger, forcing the plunger upward. Slots in the side of the plunger allow the liquid to pass. Increased flow will increase the lift, exposing a greater area of the slots, so that the lift of the plunger is in direct proportion to the rate of flow of the liquid. The graduations on the dial are uniformly spaced from one end to another and read direct—without constants. The entire instrument can be installed right in the pipe line.

For details consult Sweet's Catalog or write:

HENSZEY COMPANY
Dept. A-12, WATERTOWN, WISCONSIN



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Outstanding for extra years of dependable service in producing hi-pressure steam economically with Oil, Gas or Coal.

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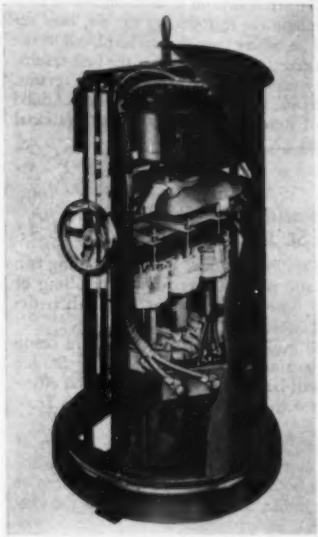
for 6" scale with pipe diameter markings

KEWANEE BOILER CORPORATION
KEWANEE, ILLINOIS

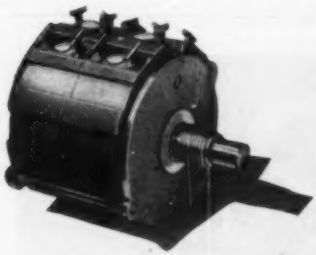
uses. Extensive field testing has shown the unit to be free of stack failure. This is accomplished by directing a high velocity downdraft of cool air over the rectifier stacks before passing this air through other parts of the machine. The blast is expelled at the base of the welder. This not only assures proper cooling, but promotes internal machine cleanliness. Features include



a case-diameter fan and "wind-tunnel" design to assure adequate, efficient air flow over all energized parts. Primary coils are raised and lowered easily on ball bearing jacks. The machine is available in 200, 300 and 400 amp ratings.

47—Potentiometer permits simultaneous control

Simultaneous control of 2 to 20 circuits with precision is possible with a potentiometer produced by Clarostat Mfg. Co. Designated as series 42A, this unit is encased in a mineral-filled bakelite housing designed to lock together with similar units to form



a single tandem assembly. Mechanical rotation may be continuous or limited. Electrical rotation is 345 degrees, and can be adjusted within one degree. Resistance range is 100 to 100,000 ohms for linear windings. Tapered windings are also available.

A
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boiler
tube
maintenance
The crew in the boiler room always rate Airetool tube maintenance equipment Ace High. They know, for Airetool tube cleaners and expanders are rugged and powerful ... easy to handle ... get the job done safely in quick time.
Airetool boiler tube cleaners remove the most stubborn scale deposits inside or outside boiler tubes quickly and safely. Airetool boiler tube expanders produce neatly rolled joints to withstand the extremely high boiler temperatures and pressures used today.
Check your boiler room maintenance equipment now. Make sure it includes Airetool boiler tube cleaners, expanders and their accessory tools. Then you will be sure you can keep your power plant in top condition. Write The Airetool Mfg. Co., 318 S. Center Street, Springfield, Ohio
Airetool cleaner with forwardly swing arm type cutter head for curved boiler tubes.
Airetool boiler tube expander with 3 expanding rolls and thrust collar that bears on tube sheet.
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There's an AIRETOOL Tube Cleaner and Tube Expander for every Type of Tubular Construction

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ANUM-METL Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES

Reducing Valve | Inverted Bucket Trap | Air or Vent Trap

STRONG

Spot news

(Continued from page 123)

tion for jet design and instructions on how to determine such factors as: size of air tube for introducing the air, how far apart the tubes should be, where they should be placed in the furnace wall, and construction principles for the best results. Booklet includes many valuable tables, charts and diagrams.

Copies of the handbook, which costs 50c, may be obtained from Bituminous Coal Research, Inc., 2609 First National Bank Bldg., Pittsburgh 22, Pa.

Wet Bottom Electrostatic Precipitators To Be Installed at St. Joe Paper

The St. Joe Paper Co., Port St. Joe, Fla., is installing two wet bottom electro-static precipitators for the handling of gases from two spray type recovery furnaces. Each is designed to handle 138,000 cfm at 275-300 F.

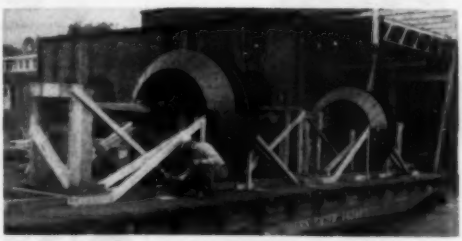
These precipitators, built by Research Corp., are being included in a new extension to the already existing St. Joe Paper Co. plant and will have a guaranteed collection efficiency of 93 per cent for the recovery of sodium salts from waste material.

Instead of collecting dust in hoppers at the bottom of the precipitator, and conveying it in the dry state to black liquor tanks, these wet bottom units utilize a liquor sump or tank, which is directly under and an integral part of the Cottrell precipitator. Black liquor flows to this wet bottom where the recovered dust is taken up in solution or suspension. During this continuous process, black liquor discharges to the feed going to the disc evaporators.

The wet recovery system does away with handling dust in the dry state. Steam coils and heat insulation, formerly needed to prevent condensation in the hoppers, are eliminated.

Nation's First Large Centrifugal Ammonia Compressor Installed by Monsanto Chemical

The first large centrifugal ammonia compressor ever installed in this country will be used for process refrigeration at the Monsanto Chemical Co. plant, Nitro, W. Va. Addition of this new unit, a Carrier five-stage centrifugal compressor



INDUCED DRAFT FAN OF 13,000 LB FOR MEXICO

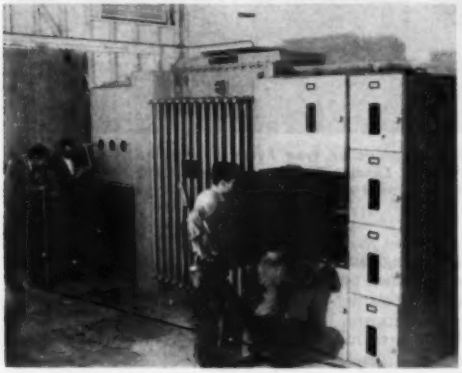
Workmen at Prat-Daniel Corp., South Norwalk, Conn., make final stowage check on huge rotors being shipped to new plant of the Mexican Light and Power Co., Lecheria, Mex.

driven by a 600 hp motor, will increase capacity of the existing reciprocating ammonia system from 400 to 800 ton. It will serve as the low stage compressor, taking ammonia gas at 25 psi suction pressure and discharging it to the high stage at 75 psi.

The centrifugal was selected, according to the Carrier Corp., because of its simplicity and low operating and maintenance costs. Construction of the compressor will be all ferrous and will be similar to those utilized for some years for air and gas compression in the petroleum and chemical processing industries.

More Power for Aviation Company Requires New Substation

Electricity for additional spot and seam welding machines to meet production schedules at Ryan Aeronautical Co., San Diego, Cal., required an immediate new substation. A one-time compressor room was used for housing the equipment.



Ryan Aviation adds new substation with 1000 kva transformer and switchgear to meet heavier production schedules

A trench, 1200 ft long and 4 ft deep was excavated for a 12,000 v lead-covered cable encased in concrete. Two manholes, 8 ft deep and 6 ft square were provided for access to the cable for splicing and maintenance.

A 1000 kva General Electric transformer and a 12,000 v switchgear were installed. Six large secondary distribution lines, rigid iron conduits each carrying 440 v, were connected from the transformer and routed overhead into the plant. A large outdoor oil circuit breaker was installed as overload protection for the underground cable and substation. Another transformer of 1500 kva has been obtained for further expansion.

Assembly of Fifth Hydraulic Turbine for Pickwick Landing Now in Progress

The fifth Kaplan propeller type hydraulic turbine for the TVA Pickwick Landing station is being assembled at Allis-Chalmers. This turbine, one of the last two for Pickwick Landing, is rated 55,000 hp under 43 ft head at a speed of 81.8 rpm. Its cast-steel stay ring has an outside diameter of 37 ft 4 in., a height of 14 ft 4 in. and weighs about 225,000 lb.

The pit liner, mounted above the stay ring, shows one of

(Continued on page 154)

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HOUGHTON

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. . . Dissolves sludge 10 times faster!

. . . Keeps lines and burners clean!

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For round-the-clock furnace efficiency you can rely on Houghton Houghto-Solv. It's the swift, sure way to remove sludge and make it pay!

Every gallon of Houghto-Solv keeps up to 4000 gallons of fuel oil free of damaging sludge. Permits you to burn all the fuel oil you buy. Saves you money every minute!

We urge you to try this fast-acting additive, especially if you use heavier fuel oils. We will send you a sample to test, along with full information, when you mail coupon below to E. F. Houghton & Co., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

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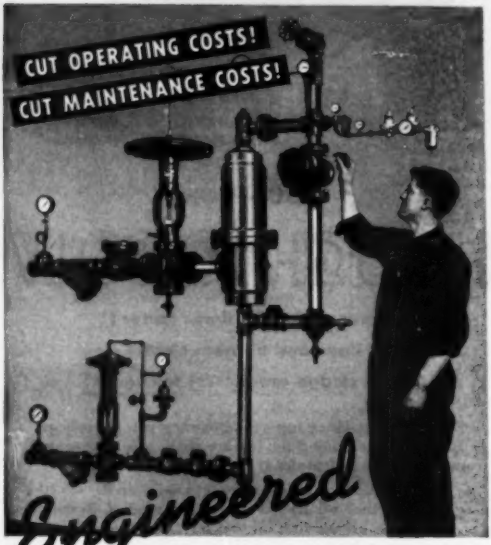
THE SURE WAY TO
CUT HOT WATER
Costs!

Pick INSTANTANEOUS WATER HEATERS



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ANY VOLUME OF WATER
AT THE TEMPERATURE REQUIRED!

Here's the money-saving answer to hot water required for industrial needs. PICK Heaters provide hot water *instantly* — by steam injection. They're entirely automatic to provide and accurately maintain temperatures up to 180° F. The exclusive Pressurizer Piston stabilizes injection pressure — eliminates pipe hammering and shaking. Available in seven sizes with rated capacities of 10 to 200 gallons per minute. Greater volumes can be obtained by multiple installations. Installation is simple, requiring only ordinary pipe connections.

NO STORAGE TANKS NEEDED
Compact design permits installation in corners, on walls or overhead.

EASILY CLEANED
No coils. Can be cleaned in a matter of minutes — without dismantling.

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BY PERFORMANCE IN
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Write for Engineering Details and Specifications. Write Dept. IP6

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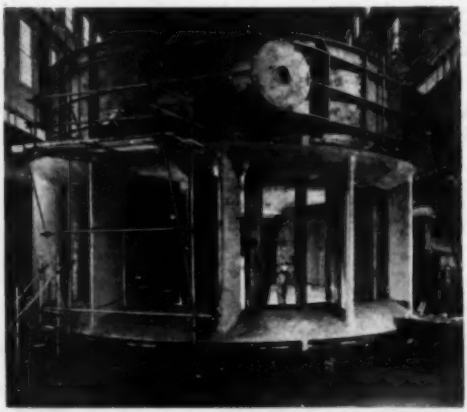
PICK MANUFACTURING CO.
WEST BEND, WISCONSIN, U.S.A.

Spot news

(Continued from page 153)



Kaplan propeller type hydraulic turbine ready for TVA Pickwick Landing Station. Two such units are being built. Each is rated at 55,000 hp under a 43 ft head at 81.8 rpm

the two regulating cylinder supporting pockets. The wicket gates in open position and the inner head cover which supports the bearing can be seen through the stay vanes.

Two Pickwick Landing turbines were put in operation in 1938 and two more were installed in 1942. The present two units will complete the number planned for this installation. They are the largest in physical size in this country.

Controlled-Circulation Boilers For Electric Utilities

There are now building, or on order, 18 large high-pressure steam generating units of the controlled-circulation type for nine central stations in this country, which indicates a marked trend in the electric utility field. These units, ordered from Combustion Engineering-Superheater, Inc. range in rated steam output from 750,000 to 1,450,000 lb per hr and in design pressures from 1670 tp 2650 psig. All employ reheat of 1000 or 1050 F and initial steam temperatures run from 1000 to 1100 F.

The distinguishing feature of the controlled-circulation type is employment of orifices to regulate water to the various heating circuits. These, aided by the flow resistance provided by the small-diameter tubes, afford close control of water distribution.

With natural circulation the difference between the weight of water in the downtakes and that of the mixture of steam and water in the risers produces circulation. Since there is a high increase in steam density and a marked decrease in water density at high pressures, this difference becomes less as the pressure increases. However, with controlled circulation the head is positively augmented by the pump. This also permits a wide latitude in the arrangement and location of the heat-absorbing surfaces and drum.

Employment of circulating pumps permit the use of small-

diameter (1¼ to 1⅜ in.) thin-wall tubes. For the same hot-face temperature these thin walls have nearly double the permissible heat absorption of natural-circulation tubes. Since other considerations dictate that furnaces of both types of units be about the same size, with little difference in heat absorption per square foot of radiant surface, the small-diameter thin-wall tubes offer greater safety against undesirable thermal stress.

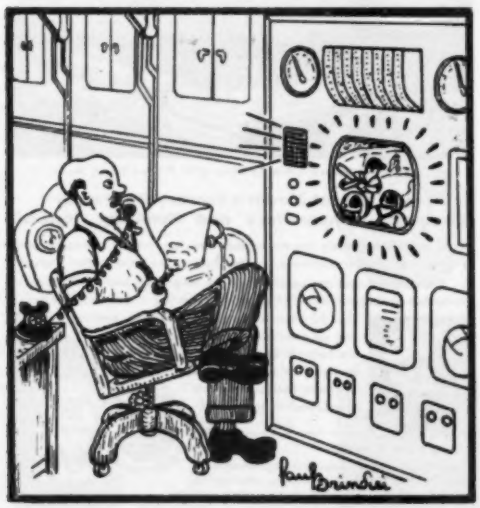
The pumps, by providing forced circulation in starting, permit rapid pickup of heat by the water in all parts of the boiler. This equalizes stresses and thereby allows the unit to be brought up to operating conditions in minimum time. Also less time is required when shutting down, and since there is less water in the unit time is saved in draining.

Problems of Pump Inlet Design To Be Studied at Improved Test Flume

Studies of inlet designs for vertical, axial and mixed flow pumps will be facilitated by an improved test flume recently installed at the West Allis Works of the Allis-Chalmers Manufacturing Co. Glass partitions in the side of the flume permit photographing a variety of phenomena, including whirlpools terminating at the water surface, on the sides of the tank, the bottom of the tank, and between two pumps.

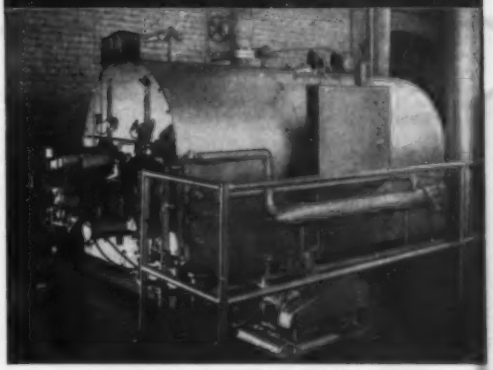
Some of the general solutions so far evolved to intake structure problems have been relocation or redesign of channel walls, floors and ceilings; guide vanes for more uniform flow; removal or redesign of obstructing members; baffles at or near the suction bell; floating grids to prevent air from being drawn into the pumps; and turning vanes under the suction bell.

The tests are timely because vertical, mixed and axial flow pumps are finding increased popularity in central stations and industrial powerhouses. The reasons: these pumps require less floor space than horizontal units, use higher speed motors, and make submergence of the impeller a relatively easy matter.



"No, we didn't get a new boiler . . . but we did get a new control panel."

This 100 H.P. Dutton EconoTHERM SAVES $20 PER DAY!



That's on fuel alone, reports McInerney Spring & Wire Co., of Grand Rapids, Michigan

How can *you* save on steam generation costs? Consider this case: During winter, McInerney operates two 300 H.P. boilers for processing and heating. From spring to fall, one boiler supplied processing steam only.

Two years ago, analysis showed that one 100 H.P. oil-fired EconoTHERM would provide plenty of steam for processing. After this "packaged" unit was installed, *over $20 per day savings on fuel alone resulted* — throughout five to six months each year!

Labor costs also dropped astonishingly. Because the EconoTHERM is automatically operated, a few hours per week suffice to check the boiler, burner and controls. Formerly, a full-time attendant was needed. McInerney was "highly pleased" — and we're confident you'll be equally pleased with EconoTHERM performance!

Your case may be very different . . . yet Dutton may help you discover some highly important savings! Find out why the EconoTHERM's exclusive off-center firing gives you faster steaming — greater safety — and lower cost.

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Other types and sizes — 5 to 250 h.p.

See Yellow Pages in Phone Book for Dutton Representative

Dutton BOILER DIVISION
HAPMAN-DUTTON COMPANY
KALAMAZOO • MICHIGAN
Boiler Makers Since 1880

New bulletins and catalogs

(Continued from page 30)

these units are made for and can do best. Discusses advantages of design, construction and operation along with basic principles. Diagrams, drawings, charts and photos illustrate some arrangements of the units. I-T-E Circuit Breaker Co.

Frequency Converters **236**

Induction frequency converters are the subject of 4-page bulletin GEA-5637. Covers three-phase equipment in fundamentals, operation, and construction features of the high-frequency ratings from ¾ to 100 kw. Describes power supply apparatus, and includes application information, modifications, and limitations, and complete tables of ratings and frame sizes. General Electric Co.

Metallic Rectifier **237**

Metallic rectifier power-conversion units are covered in 8-page bulletin GEA5658. Describes features of the equipment, its application and operation. Illustrated with photographs, line drawings and charts showing efficiency and regulation curves for various sized units. Specification guide for d-c power supplies and exciters also is included, as well as complete rating charts and dimensions. General Electric Co.

Capacitors **238**

Information on fixed paper-dielectric capacitors is provided in 16-page bulletin GEC809. Describes operation and features of the equipment, its application and operation. Illustrated with photographs, line drawings and charts showing the derating for a-c and d-c applications. General Electric Co.

ELECTRICAL HEATING UNITS

Immersion Heaters **239**

"Packaged" electric heaters—immersion, circulation and other heaters that have built-in controls are covered in 4-page bulletin. Economical advantages are described and some applications listed. Typical installation photographs show the units at work. Edwin L. Wiegand Co.

ELECTRICAL INSULATION

Flexible Conduit **240**

Having trouble protecting electrical wiring against moisture, oil, chemicals, corrosive fumes, etc., or vibration and movement? Bulletin C201 on flexible liquid-tight conduit may help solve your problem. Tells advantages and shows installation photos covering various applications. Engineering and installation data included in the 4-page folder as is table of standard sizes. The American Brass Co., American Metal Hose Branch.

Industrial Tapes **241**

Ingenious industrial catalog in the form of five file cards in a cardboard folder, provide information on industrial tapes. Cards are labeled "General Purpose Tapes", "Electrical Tapes", "Special Purpose Tapes", and "General Information". Across each card are sample strips of the tapes described, along with technical specifications, general information on uses, etc. Polyken Industrial Tape, Dep't of Bauer & Black.

FANS AND BLOWERS

Ventilating Fans **242**

Various types of industrial ventilating fans for removing smoke, heat, steam and fumes are illustrated and described in series of data sheets numbered 973 through 982. Capacities range from 850 to 58,500 cfm. Dimensions, specifications and recommendations given. Chelsea Fan & Blower Co., Inc.

Ventilation Guide **243**

Helpful guide covering general problems in industrial ventilation gives economical solutions. The 16-pages of information include chapters on types of ventilation, air velocity, system pressures, certified ratings, fan types, selection, do's and don't's, and resistance calculations. Informative tables, charts and diagrams provide a great deal of engineering data. Chelsea Fan & Blower Co., Inc.

Blowers **244**

Axial flow, positive pressure blowers for handling gas or air under pressure or vacuum are presented in 12-page bulletin 51759. Cross section shows principal component parts and photo-

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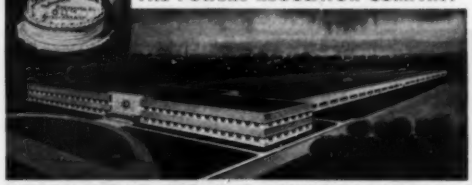

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(286)

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graphs portray various types and models. Capacity tables and specifications along with charts showing test results are given. List of applications and description of accessories included. Read Standard Corp.

FUELS & FIRING EQUIPMENT

Burners **245**

Information on burners for light and heavy oils and for the various gases in popular use is contained in 16-page bulletin. Discusses the burning of various fuels and then shows how the "dry" atomization principle makes for efficient combustion. Drawings and photographs along with descriptive matter show some arrangements possible with basic, stock models. On-the-job photographs included. Lammert & Mann Co.

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Combustion Equipment **246**

Compact and comprehensive bulletin illustrates and describes complete line of burners, mixers, valves and blowers used in gas combustion for industrial purposes. One page is devoted to gas and oil-fired steam boilers and furnaces for the process industries. Pamphlet is designed to show the wide variety of products, and the range of sizes in which each is obtainable. More detailed bulletins on specific equipment are available. Eclipse Fuel Engineering Co.

HEAT EXCHANGER EQUIPMENT

Tubes & Plates **247**

Engineers responsible for the selection of materials in steam power plants will find an expanded 44-page edition of "Tubes and Plates for Condensers and Heat Exchangers" particularly valuable. In addition to application and installation data, booklet also discusses operation and corrosion factors affecting tube life and service. Also valuable information on compositions of alloys, and tables on physical and tensile properties, working stresses, weights, and a convenient conversion table. Well illustrated. The American Brass Co.

Heat Exchanger **248**

Simple method of controlling the temperature of liquid or gas is explained in 4-page folder 120 on heat exchangers. Cutaway drawing illustrates how the unit operates. Flow diagrams portray how controls keep a fluid at uniform temperature. Lists numerous applications in various fields. Typical installation photographs included. Niagara Blower Co.

(Continued on page 158)

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Standard Swivel Joints. For pressures from 125 psi. to 15,000 psi.

High Temperature Swivel Joints. For temperatures to 500°F. M.W.P. 700 psi.

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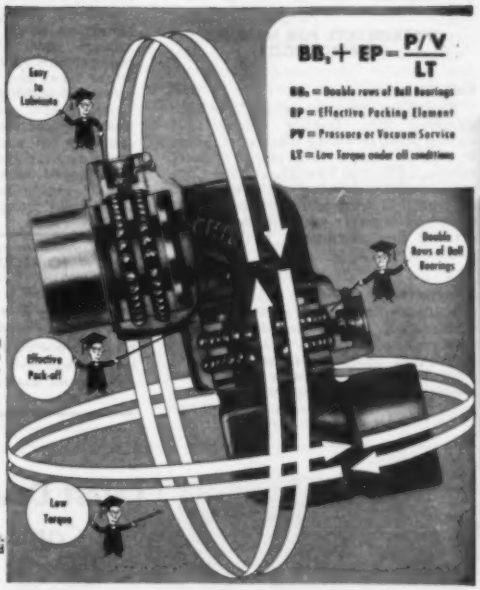
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BB, = Double rows of Ball Bearings
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Easy to Lubricate
Double Rows of Ball Bearings
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BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

New bulletins and catalogs

(Continued from page 157)

Water Heater **249**

Catalog 60, 12 pages, feature instantaneous water heaters and other industrial fluid heating units; illustrates typical installations; and gives useful sizing data, steam consumption tables and diagrams. General Fittings Co.

INSTRUMENTS FOR MEASURE OF ELECTRICITY

Volt Ammeter **250**

Eleven case histories which have been gathered into 16-page manual 504 should make servicing jobs easier. Show how pocket-size a-c volt ammeter saves time and effort in locating trouble. Contains working drawing of the unit with its specifications and mechanical dimensions together with instructions for reading the instrument. Pyramid Instrument Corp.

Telemeters **251**

Instrumentation data sheet 9.1-10 describes G-E telemetering systems and their use with Brown ElectroniK recorders in providing measurement of system variables plus wire speed transmission to central locations. Describes telemetering requirements, fields of application, basic equipment required and the operation of both frequency and torque balance type telemeters. Illustration shows basic layout of the various components of both types. Also illustrates how electric load generation and interchange can be measured at any point in a utility system and recorded at a central location. Minneapolis-Honeywell Regulator Co., Brown Instruments Div.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Planned Lubrication **252**

Bulletin BK19, 20 pages, gives full details on seven specialized lubricants said to cover the majority of plant requirements with a minimum of different types and densities. Information presented includes lubricant characteristics, benefits, uses, densities, specifications, and container sizes. Covers lubricants for ball and roller bearings, plain and ring bearings, open gears, enclosed gears, speed reducers, and oils for cleaning, loosening and penetrating. Keystone Lubricating Co.

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Industrial Lubricants **253**

Bulletin 93 presents 8 pages of industrial case histories describing the use of lubricant compound in various applications. Explains the principle of the lubricant which contains a molybdenum-disulfide powder as a basic ingredient. The Alpha Corp.

Oil Purification **254**

Purification methods, adapted by two large electric utilities, in restoring used insulating and transformer oils to new oil specifications are described in two case histories. One folder explains and illustrates how installation of complete, portable unit for purifying, dehydrating and degasifying insulating oils, provided a mobile refinery. Summary of complete findings on the equipment is contained. Preventive maintenance program to keep insulating oil safe to use indefinitely is described in the second case history. Shows how the unit mounted on a truck, services all oil filled electrical equipment. Both case histories describe, in addition, purification equipment for turbine and diesel oils. Honan-Crane Corp.

Hydraulic System Filters **255**

Complete engineering data on synclinal type filters for sump or line installation on all hydraulic and low pressure liquid recirculating systems is contained in 8-page folder 105. Marvel Engineering Co.

MATERIALS OF CONSTRUCTION

Steels **256**

Quick reference wall chart shows chemical analyses and other data on more than 275 different grades of standard and alloy steel bars. Arranged in order of their AISI numbers. La-Salle Steel Co.

Electrical Steels **257**

New data and information on thin electrical steels are presented in 32-page booklet. These data are said to permit the selection of electrical steels for high frequency equipment without theoretical determinations, extrapolation of meager data, or the use of empirical formulas. Representatives test results are presented in 21 pages of curves giving the magnetic properties of three iron-silicon alloys. The curves show core loss, exciting rms va per lb, a-c permeability, induction versus frequency, figure of merit and lamination factor. Also describes the general characteristics of the three grades. Armco Steel Corp.

Aluminum Bronze Alloys **258**

Complete information on aluminum bronze alloys as applied in corrosion-resistant service is given in 20-page bulletin PI-3. Includes corrosion-erosion-resistance and cavitation-pitting data along with physical and chemical properties of various aluminum bronze alloys recommended for such service. Information concerning corrosion-resistant aluminum bronze centrifugal pumps, plug valves, pipe, tube, fittings, tube sheet and available testing facilities is included. Ampco Metal, Inc.

Copper Alloys **259**

The word "brass" as it is commonly used covers a wide range of copper base alloys, each of which has differ-

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Latest Developments in Control Valves for Air · Gases Liquids · Semi-Solids

The W. S. Rockwell Valve News describes new developments in Rockwell automatic and manually controlled Butterfly Valves, Slide Valves and valves of special design for use in plant piping and processing equipment for control and shut-off.

It presents interesting ideas in design, construction, method of valve operation and industrial applications to meet the various conditions of physical and chemical nature of the material handled, pressure and temperature.

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ences and particular advantages. To help industry to distinguish between the alloys a 4-page folder lists 65 commonly used brass and copper alloys, along with their composition, properties, forms and typical uses. Bridgeport Brass Co.

Nickel Irons **260**

"Engineering Properties & Applications of Ni-Resist" is a 36-page bulletin describing eight types of austenitic nickel alloy cast irons that offer unique combinations of properties. Applications and comparative service data in many industrial fields are presented. The booklet is well illustrated with photographs, tables of properties and corrosion data on nearly 400 conditions. The International Nickel Co., Inc.

MECHANICAL POWER TRANSMISSION

Driveshafts **261**

Bulletin gives complete data and specifications on radial drive shafts with spline-jointed tubular shafts; universal driveshafts with one-piece tubular shafts; and universal driveshafts with spline-jointed tubular shafts. Also provides a working table of maximum recommended lengths and speeds. Morse Chain Co.

V-belts **262**

Features built into Condor V-belts are described in 4-page bulletin 6868E. Construction features are explained and typical applications in various industries illustrated. Table of standard industrial sizes and list prices included. Raybestos-Manhattan, Inc., Manhattan Rubber Div.

Roller Chains **263**

Double pitch roller chains are pictured and described in 12-page bulletin 51-2. While not a substitute for standard chains the booklet describes how these chains can often effect both cost and weight reductions in drives and conveyers for applications where speeds are slow to medium, loads are moderate, or where centers are long. Charts, photos, diagrams and tables show in detail both drive and conveyer types, and standard attachments. Useful selector chart makes it simple to choose chains. Also describes double pitch chain sprockets. Chain Belt Co.

MOTORS & GENERATORS

Totally-enclosed Motors **264**

Construction details of totally-enclosed, fan-cooled motors suitable for use where dust, moisture or corrosive gases exist are pictured and described in 6-page bulletin 51B7225. Tabular information includes dimensions and horsepower—frame data. Available in sizes from ½ to 100 hp. Also available in non-ventilated type. Allis-Chalmers Mfg. Co.

Explosion-proof Motors **265**

Application and construction of explosion-proof and totally-enclosed motors is discussed in 8-page bulletin 1629-80M. Well illustrated with 4-color photographs, cross sections and large cutaway drawing of motor. U. S. Electrical Motors, Inc.

PACKAGED STEAM GENERATORS

Steam Generators **266**

Four-color 16-page booklet on packaged steam generators, profusely illustrated with photographs, cut-away and schematic drawings, describes in detail construction and operation principles. Charts and tables provide essential data, dimensions, specifications and test results. Explains such subjects as induced draft; dry steam; 4-pass downdraft design; 5 sq. ft of heating surface per bhp; flexibility of operation; and oil, gas, and combination gas/oil burning equipment. Superior Combustion Industries, Inc.

Steam Generators **267**

Information on units for steam or hot water use is presented in bulletin 1218. High or low pressure units from 15 to 500 hp are described. Gives details on special burner design and shows how quickly the unit can be changed over from oil to gas firing. Orr & Sembower, Inc.

(Continued on page 160)

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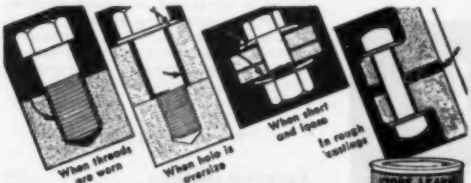

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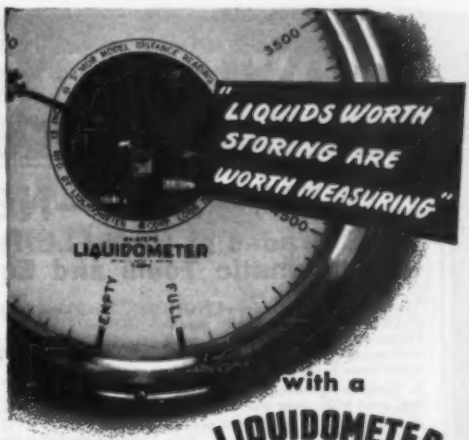

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New bulletins and catalogs

(Continued from page 159)

PUMPS

Controlled Volume Pumps **268**

Bulletin 251, 24-pages, illustrates and describes features of construction and applications for motor-driven controlled volume pumps. Metering accuracy to a fraction of 1% is possible in most applications in capacities from 3 milliliters per hr to 50 gpm against pressures up to 20,000 psi. Pumps are reciprocating, positive displacement type. Handles practically any liquid. Includes capacity pressure selection tables, and tables of dimensions and shipping weights. Milton Roy Co.

Centrifugal Pumps **269**

One and two stage volute, saddle-mounted, vertically split centrifugal pumps for refinery service are described in a 12-page bulletin W-341-B2C. Illustrated with dimension and cross section line drawings. Please mail request on company letterhead. Worthington Pump & Machinery Corp.

Wet-pit Pumps **270**

Bulletin W-317-B12 describes line of pumps having non-clogging impellers capable of passing solids and stringy material for sump, sewage and drainage service. The stuffing box is above the impeller and the pump bearings are above and separate from the box. Stuffing box packing requires no adjustment. Bulletin includes cross-section drawing, graph of 60-cycle motor speeds, dimensions and data on flanges. Please mail request on company letterhead. Worthington Pump & Machinery Corp.

PACKINGS & GASKETS

Asbestos Packings **271**

High pressure asbestos packings with rubber back, rubber core, or dual edge designed for use on valve stems, piston rods, pump shafts, and expansion joints are illustrated and described in 4-page bulletin. Includes service recommendations, list of standard sizes, and specifications of standard packages and approximate weights. Raybestos-Manhattan, Inc., Packing Div.

Asbestos Packings **272**

Braided and twisted asbestos packings designed for use on valve stems, are illustrated and described in 8-page bulletin. Gives service recommendations; lists standard sizes, specifies standard packages and gives approximate weights of the several types. Raybestos-Manhattan, Inc., Packing Div.

PIPE AND FITTINGS

Bellows, Flexible Hose **273**

Sixteen-page illustrated catalog CMH-123 gives complete description and specifications on wide line of metallic bellows and flexible metal hose and tubing. A wide variety of applications and uses are compiled for quick reference. Catalog should be especially helpful to engineers concerned with metal hose or bellows. Please address request on company letterhead. Chicago Metal Hose Corp.

Expansion Joints **274**

Diversified line of standard and special bellows type expansion joints described and illustrated in 40-page catalog 51. Sizes range from ½ to 72 in., covering pressures from vacuum to 1000 lb. Bellows are fabricated from stainless steel and various alloys to meet a wide variety of applications. Complete data are presented in handy table form. Also includes table on thermal expansion of steel pipe. Solar Aircraft Co., Bellows Div.

REFRACTORIES

Refractory Coating **275**

Four page illustrated bulletin describes refractory coating made from ceramics and metallic materials. Serves as a preventative against slag penetration, abrasive wear, flame erosion, corrosive gases, molten metal, and thermal shock. Coating is used in such applications as heat treating furnaces; kilns, ovens and boilers. Bulletin states refractory life is increased by as much as 30%. Please mail requests on company letterhead. Williston & Co.

Silica Cement **276**

Descriptive information on silica cement for use in laying silica refractories is contained in 4-page bulletin. Includes photographs showing results of comparison tests. Among properties illustrated are comparative effects of heat treatment, refractories, trowelling and settling. Harbison-Walker Refractories Co.

THERMAL INSULATION

Equipment Insulation **277**

Useful information and data on insulation of heated pipes and such equipment as boilers, condensers, kilns, heated ducts, turbines, etc., is presented in 12-page bulletin 37-D-2. Includes description and photos of product, specifications for numerous applications, and information and photos concerning means of application to specific surfaces. Selective index simplifies the location of specific applications. Owens-Corning Fiberglas Corp.

Magnesia Insulation **278**

Magnesia insulation for covering pipe, fittings and equipment is presented in 2-color, 8-page bulletin 4H. Sectional forms up to 18 in. pipe size

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are available. Discusses physical properties and advantages. Also includes recommended application procedures and list of insulating and finishing cements. Contains quick reference tables of recommended thicknesses. Ehret Magnesia Mfg. Co.

All-purpose Insulation **279**

All-purpose plastic insulation is the subject of 4-page catalog 1-88. Can be used on metal, tile, brick, glass or any other clean surface, hot or cold, adhering permanently, without lifting off or shaking loose even when subjected to severe vibration, abrasion or impact, it is claimed. Booklet states that it is strong, light, adhesive, easy to apply, durable, reclaimable and efficient to 1800 F. Contains instructions for application and recommended uses. Illustrated with numerous photos and includes chart of recommended thickness. Refractory & Insulation Corp.

STEAM SPECIALTIES

Preheater **280**

How live steam is used to heat water or other liquids without noise or vibration is explained in 8-page bulletin H104 on silent preheaters. Major applications include hotwells, filter boxes and feedwater heaters. Lists advantages and gives full installation instructions complete with diagrams showing do's and don'ts. Cross section drawing presents design & construction features as well as dimensions. Sims Pump Valve Co.

TRANSFORMERS

Transformers **281**

Dry type auto and double wound power circuit transformers are presented in 8-page bulletin 501-15. Lists transformers having various primary and secondary voltage combinations with double wound transformers available in capacities ranging from 50 to 15,000 va, auto type transformers 100 to 10,000 va inclusive. Contains diagrams, charts and photographs along with typical selection problem. Dimensions and other data included. Jefferson Electric Co.

VALVES

Instrument Valves **282**

Bulletin 2Q discusses how to save time and money using one valve to replace the multiple set-up of valves and connections formerly used for instrument and regulator piping. Diagrams show various applications and compare old methods of connecting gages. Construction features, specifications, sizes and dimensions are given. Jerguson Gage & Valve Co.

Safety Valves **283**

Adequate protection for equipment operating on the down-stream side of pressure regulators is fully discussed in a 16-page bulletin, "Sizing Safety Valves for Pressure Reducing Regulators". Includes valuable 2-color charts showing capacity required from safety valves for 100% protection in case of regulator failure, and volume-weight charts for determining volumes per lb of gases for various specific gravities, pressures and temperatures. Marine & Industrial Products Co.

Water Hammer **284**

Cause, effect and control of water hammer in piping systems are considered in 8-page bulletin WH951. After describing water hammer in non-technical terms, the brochure indicates its potential damage to piping, instruments and other parts of water systems, and then considers methods of controlling it. Also included are results of tests made to determine what effects check valves have in overcoming water hammer. Findings reported for water hammer are believed equally true of other liquids, according to the booklet. The Williams Gauge Co.

Check Valves **285**

Silent check valves, designed to prevent water hammer, are described and illustrated in 4-page bulletin WH100. Said to not only eliminate noises, but also prevent the pressure surges which can result in damage to piping systems. Booklet includes technical data, cutaway versions of two types of valves and series of installation photographs. Available in all regular pipe line sizes from 1 through 20 in. The Williams Gauge Co.

Power Plant Valves **286**

Handy, quick reference guide to cast and forged steel valves illustrates and describes only those valves applicable to power plant use. Other valves are listed, but with brief descriptions only. The pictorial content covers blow-off, instrument, non-return, cast steel check, and cast and forged steel globe and angle valves. Lists design and construction features. Edward Valves, Inc.

WATER TREATMENT

Feedwater **287**

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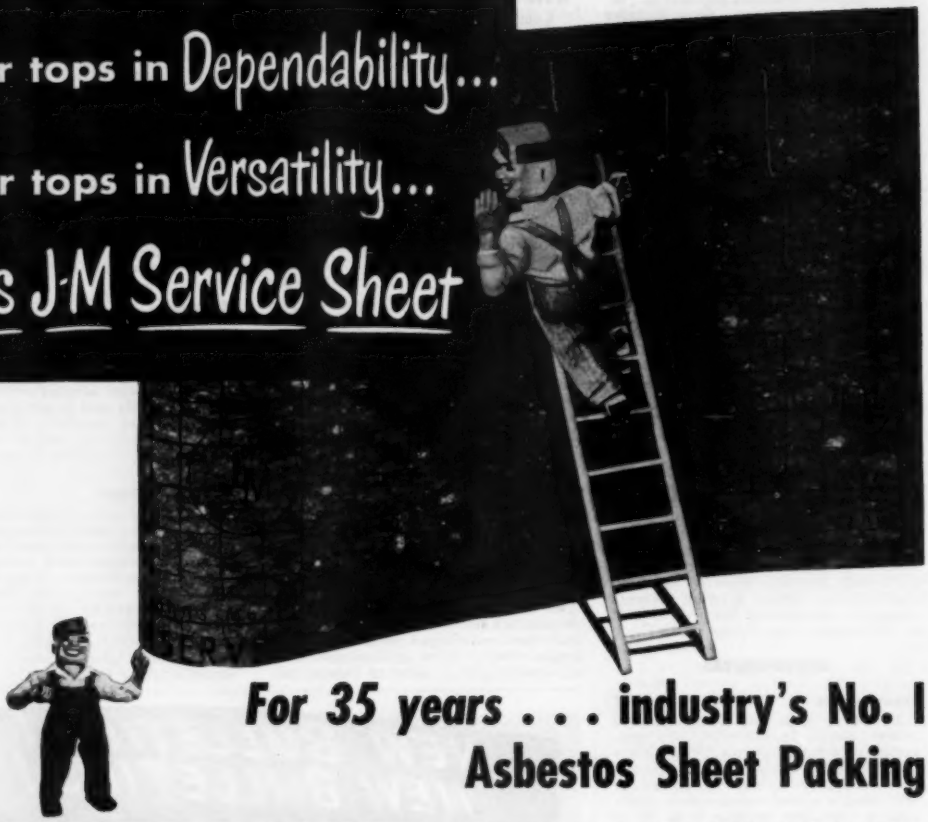

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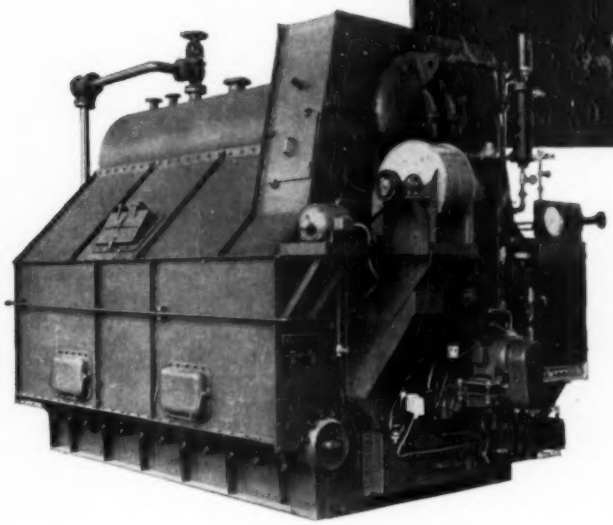

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